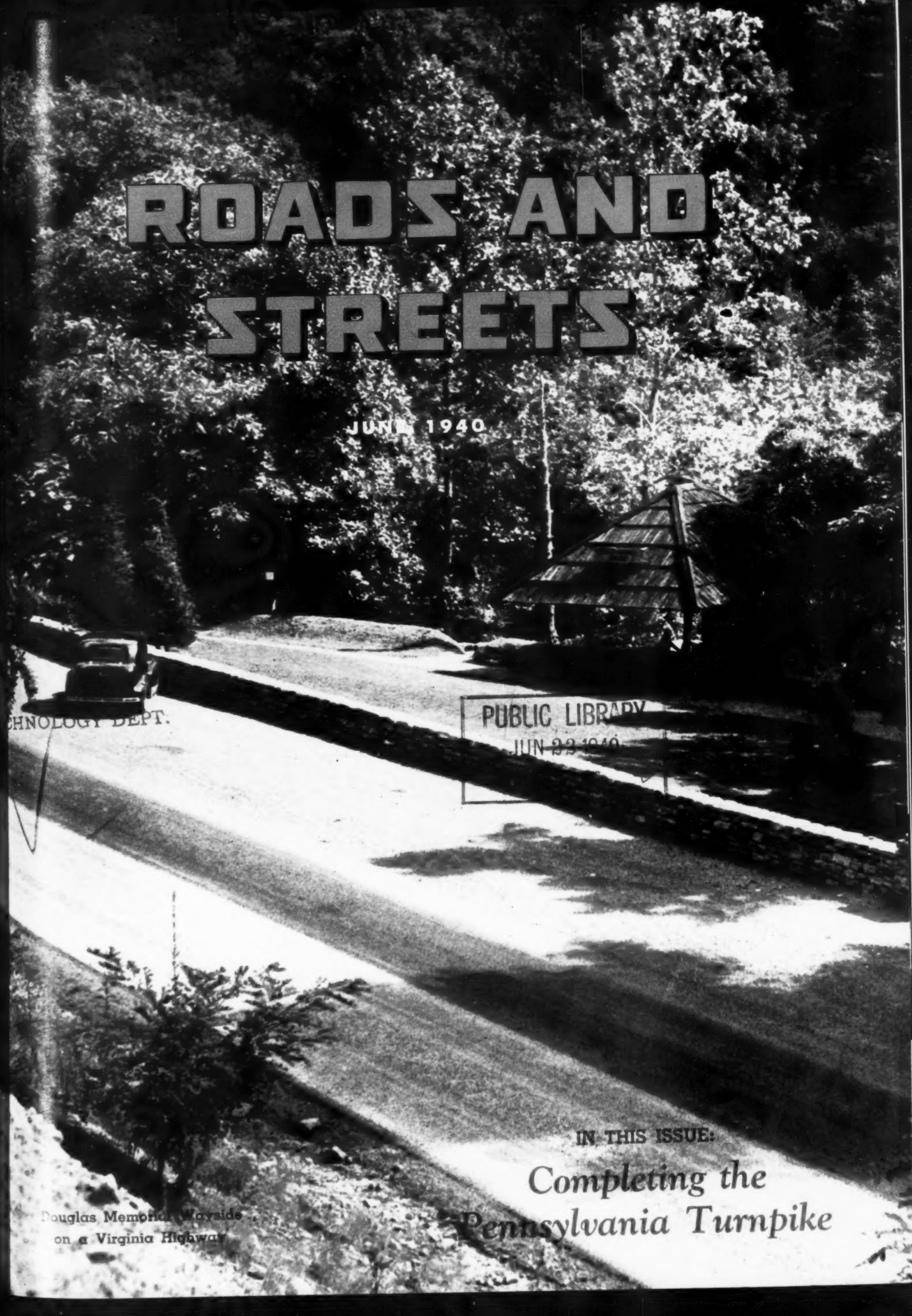


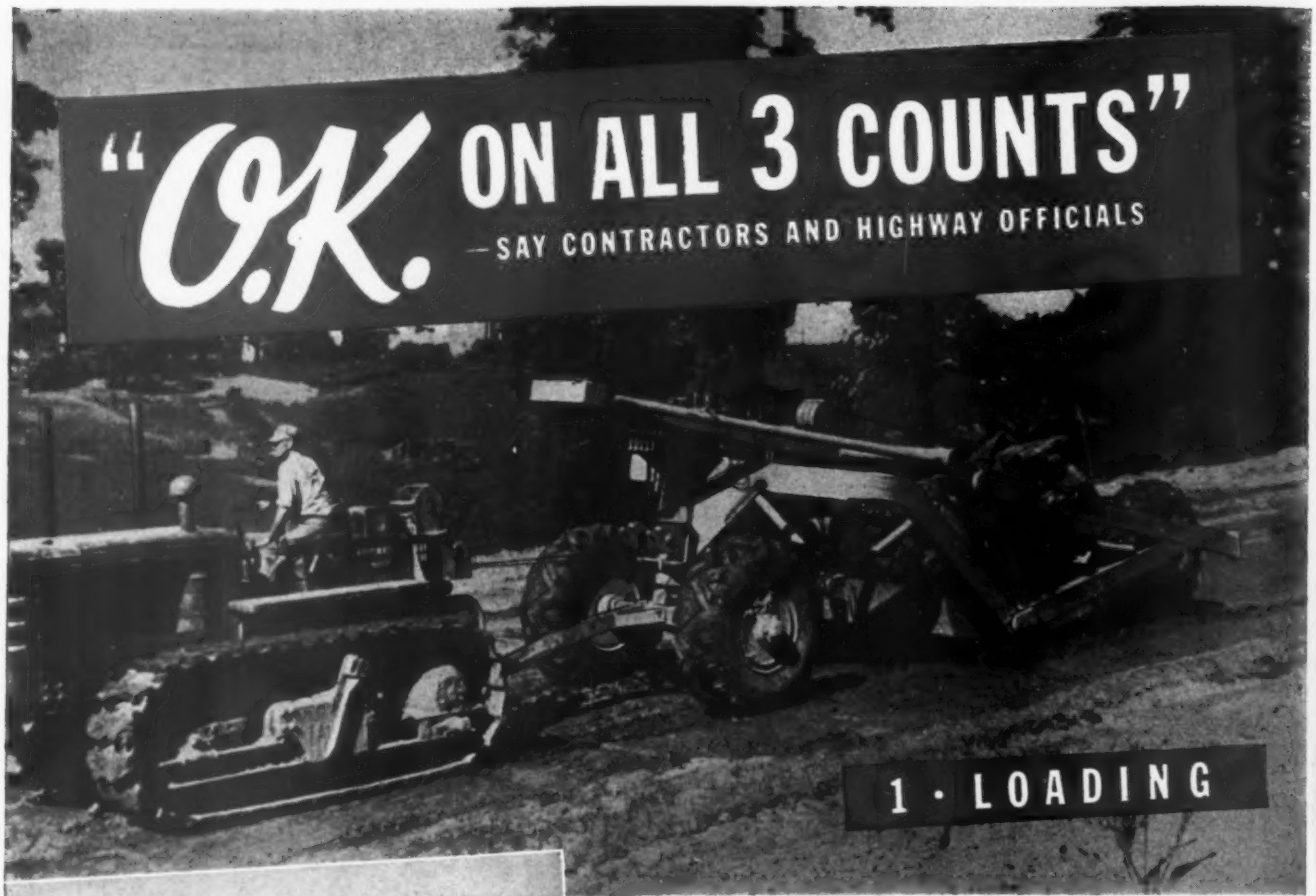
ROADS AND STREETS

JUNE 1940

IN THIS ISSUE:

Completing the Pennsylvania Turnpike

Douglas Memorial Wayside on a Virginia Highway



EVERYWHERE they go, on all types of earth-moving jobs, Adams Hauling Scrapers meet with enthusiastic approval and here's why:

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Adams Hauling Scrapers are available in 3¼, 5¼, and 11¼ yard sizes. See your local Adams representative for a demonstration on your job or write

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ADAMS Hauling Scrapers

Under Car Headlights Only –

WHITE REFLECTING
GREATER VISIBILITY

New Jersey state highway engineers developed this concrete curb with a face of white concrete and a reflecting saw-tooth design. With no other illumination than car headlights, White Reflecting Curb shows up brightly on dry nights and even more brightly on rainy nights. It also dominates road by day.

ON BUSY New Jersey highways this new type of curb increases night driving visibility to an astonishing degree. So effective is it that the curb itself seems to be lighted, but actually it is simply the reflected light from the driver's headlights. Instead of reflecting the light away from the driver, as with ordinary curb, the white concrete saw-tooth faces of this curb catch and reflect the light back to the driver.

These reflecting faces are specially designed to vary in height and curvature, and so reflect headlight beams close to the car, far away, and in between, thus creating a continuous ribbon of light.

White Reflecting Curb is based on the simple fact that the eye sees only light rays, either reflected or direct from a source, and that the night driver sees a curb only when it reflects headlight rays back to his eyes.

Designs have been constantly improved as a result of continuous research, testing, and the installation of many miles of this type of curb during the past few years along New Jersey's principal traffic arteries.

New Jersey engineers say that White Reflecting Curb costs little or no more than ordinary curb. It stays white without painting or other upkeep as long as the road lasts. Because it is so economical to make and maintain, and cuts down day and night accidents, White Reflecting Curb pays for itself quickly. Curbs are precast (Fig. 5), or cast-in-place (Figs. 3 and 4).

Send today for more data on White Reflecting Curb made with Atlas White Cement. Write Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Dept. C2, Chrysler Building, New York City.

Photographs by courtesy of New Jersey Highway Department

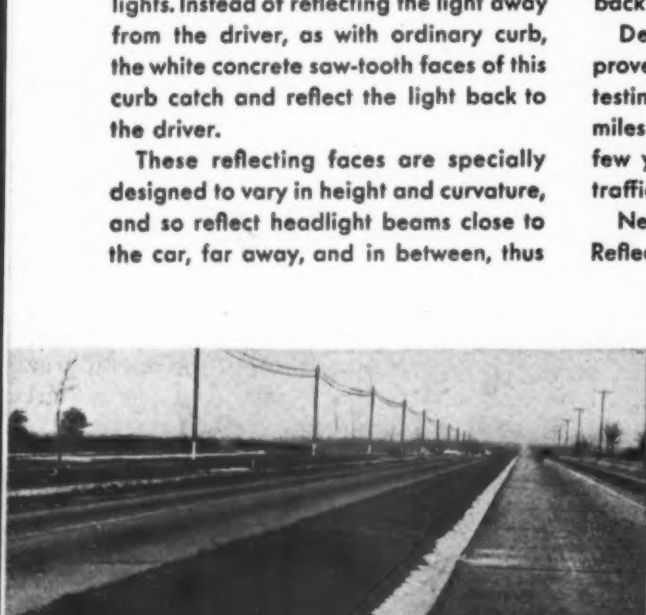

FIG. 1

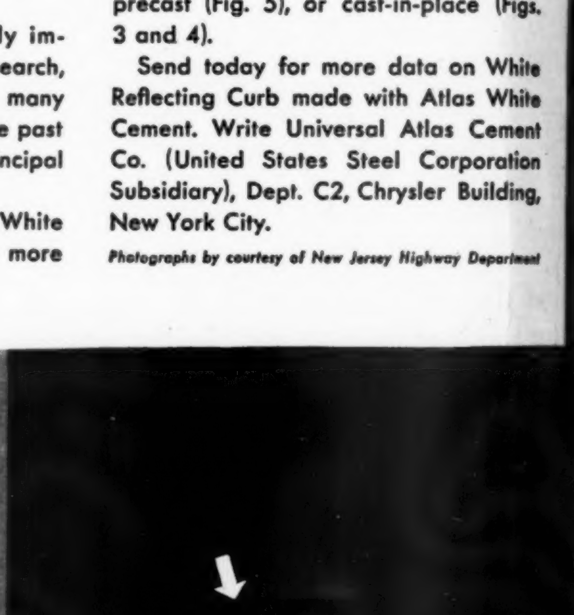

FIG. 2

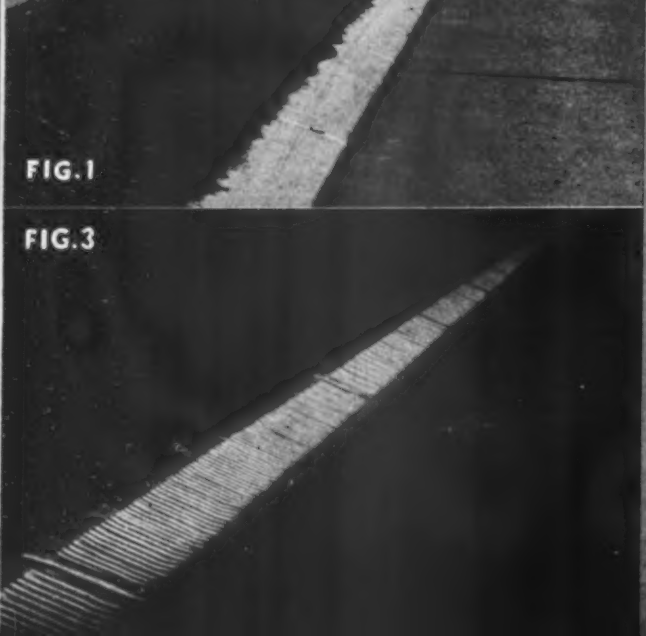

FIG. 3

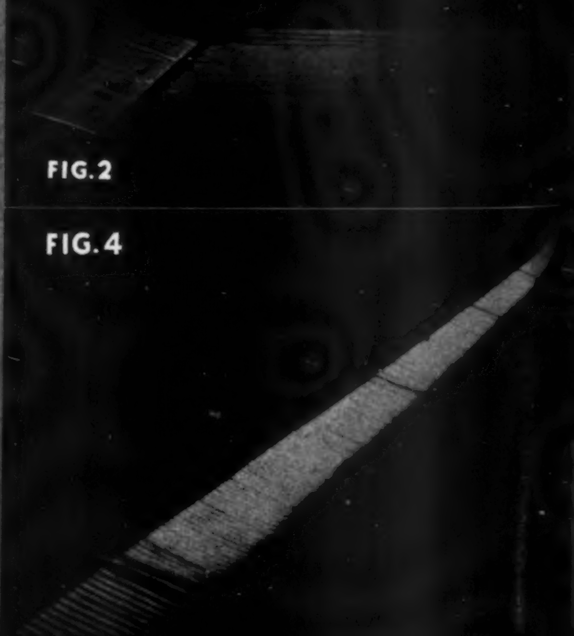

FIG. 4

Fig. 1. DOMINATES THE ROAD BY DAY! New Jersey adopted this smooth white cement curbing several years ago. It does a man-sized job of keeping day traffic apart.

Fig. 2. NOT SO GOOD AT NIGHT! On a dry night the same smooth curb is only a little more visible than road. But see what happens when it rains! Water, shown by arrow, was thrown on road and curb. Water intensifies the mirror effect, reflects more light from headlights forward—away from driver. The wet curb and pavement appear black—visibility is almost nil. (See Figs. 6 & 7 for explanation.)

Fig. 3. REMARKABLE ON DRY NIGHT! Note greatly increased visibility of this White Reflecting Curb under the same car headlights as in Fig. 2. Saw-tooth ridges reflect most of the light back to the driver.

Fig. 4. AMAZING ON RAINY NIGHT! Water has caused road to disappear in blackness. But this White Reflecting Curb is even brighter than on the dry night shown in Fig. 3. The high visibility is due solely to reflection from car headlights.

—No Other Illumination

CURB PROVIDES FOR NIGHT DRIVING

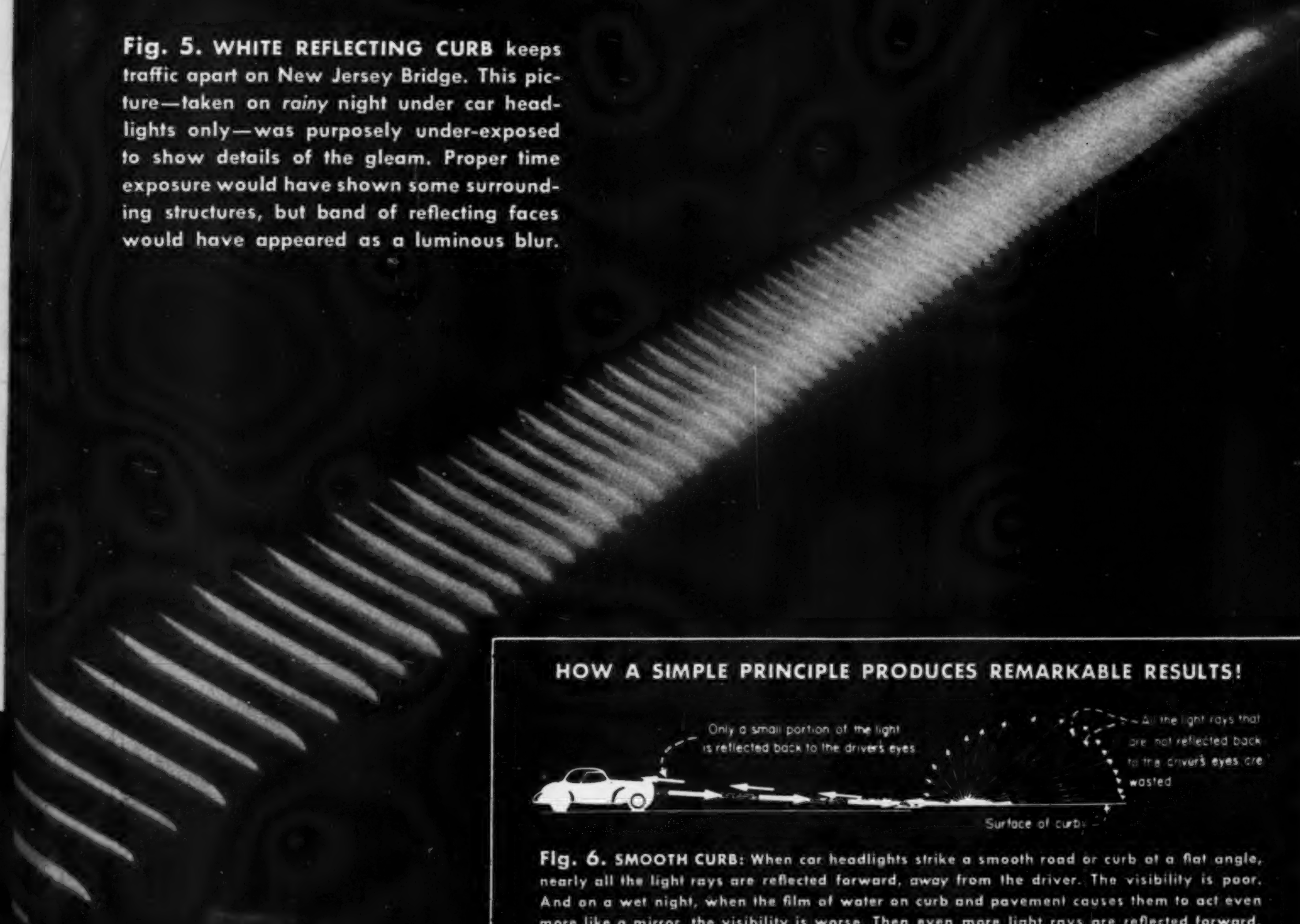

Fig. 5. WHITE REFLECTING CURB keeps traffic apart on New Jersey Bridge. This picture—taken on *rainy* night under car headlights only—was purposely under-exposed to show details of the gleam. Proper time exposure would have shown some surrounding structures, but band of reflecting faces would have appeared as a luminous blur.

HOW A SIMPLE PRINCIPLE PRODUCES REMARKABLE RESULTS!

Fig. 6. SMOOTH CURB: When car headlights strike a smooth road or curb at a flat angle, nearly all the light rays are reflected forward, away from the driver. The visibility is poor. And on a wet night, when the film of water on curb and pavement causes them to act even more like a mirror, the visibility is worse. Then even more light rays are reflected forward. Fewer—almost none—are reflected back to the driver. Road and curb appear almost black (as in wet area in Fig. 2).

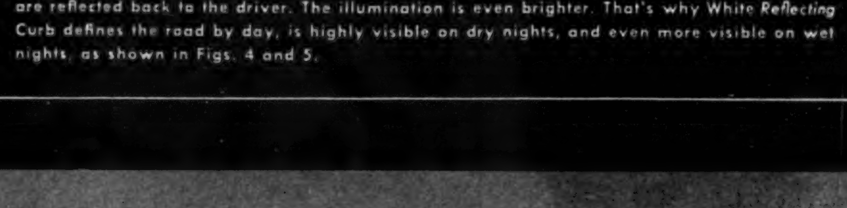

Fig. 7. REFLECTING CURB: This shows what happens when light rays strike a White Reflecting Curb. The saw-toothed faces of the curb catch the rays and reflect them back to the driver. On wet nights, these faces act even more like mirrors and even more light rays are reflected back to the driver. The illumination is even brighter. That's why White *Reflecting* Curb defines the road by day, is highly visible on dry nights, and even more visible on wet nights, as shown in Figs. 4 and 5.

WHITE REFLECTING CURB

MADE WITH ATLAS WHITE CEMENT

ADVERTISING PAGES REMOVED

ROADS and STREETS

With which have been merged GOOD ROADS and ENGINEERING & CONTRACTING

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CHICAGO, ILLINOIS

THIS MAGAZINE IS DEVOTED TO
Design, Construction and Maintenance of Highways, Streets, Bridges and Grade Separations

H. P. GILLETTE, Editor — V. J. BROWN, Publishing Director — E. S. GILLETTE, Publisher

Vol. 83 — JUNE, 1940 — No. 6

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PENNSYLVANIA TURNPIKE SECTION:

ROADS and STREETS

Vol. 83, No. 6 June, 1940

A GILLETTE PUBLICATION
ESTABLISHED 1906

"NOTHING SHALL BE PERMITTED TO STOP WORK"

A Review of Activities of the Pennsylvania Turnpike Commission

By SAMUEL W. MARSHALL
Chief Engineer
Pennsylvania Turnpike Commission

IN order that full discourse may be given to the conception, organization, design, and construction of the Pennsylvania Turnpike, of necessity the narration begins from June, 1937. It was in this month that the former governor, George H. Earle, (1935-1939) appointed the members of the Pennsylvania Turnpike Commission who met for the purpose of commission organization in the offices of the late Warren Van Dyke, former Secretary of Highways, on June 7, 1937.

The Act of Assembly which created the Pennsylvania Turnpike Commission was an excellent and progressive looking piece of legislation, but in the preparation of the act one salient feature was omitted, namely, the appropriation of any moneys to provide for the functioning of the commission. It is true that the Act provided that the Department of Highways, Commonwealth of Pennsylvania, might advance funds for engineering purposes only, and the strictest interpretation of "engineering purposes only" was insisted upon by the office of the Attorney General.

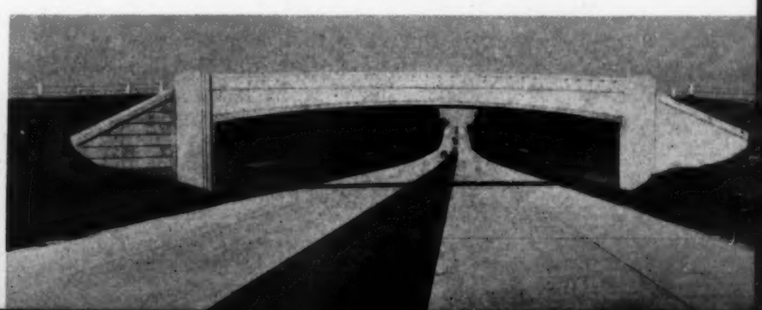
The Pennsylvania Department of Highways was charged with a careful scrutiny of any, and all, funds expended by the department for engineering, research, and personnel necessary, or required, for Turnpike purposes. At that time the engineers who were working on engineering features were assigned to the various district offices of the state highway department and were operating under the jurisdiction of the state highway department district engineers; feeling that the best results were not being obtained in this matter there was created, within the Department of Highways, an organization known as the "Turnpike Division" and field offices were established at Mt. Pleasant, Somerset, Everett, and Shippensburg, with central offices in Harrisburg to provide for independent functioning of this engineering organization under the direct supervision and authority of the Chief Engineer of the Department of Highways. The Commission met at regular intervals during the summer of 1937; the main purpose of such meetings being preliminary organization and efforts toward the financing of the project, the cost of which had not yet been determined.

Among the commission's earliest actions was the engaging of consulting engineers in connection with the design of, and ventilating for, the several tunnels that were partially driven by the Old South Penn Railroad builders, and for an independent traffic survey and report as to the character and amount of traffic that might be expected to use a road containing the characteristics of a high speed safe highway across the southern part of Pennsylvania.

Mr. Ralph E. Smillie, now Chief Engineer of the New York Port Authority, was engaged as the tunnel consulting engineer and Parsons, Klapp, Brincker-

Before

After



hoff, and Douglas of New York, was engaged to make a traffic survey and submit a report to the commission as to the estimated traffic the Turnpike would carry. Simultaneously with the preparation of the traffic report the Pennsylvania Department of Highways prepared a comprehensive and detailed estimate as to the cost of a four-lane high-speed highway extending approximately from Middlesex in Cumberland County to Irwin in Westmoreland County.

It is of paramount importance to note that at this particular time when the estimate of the total cost of the Pennsylvania Turnpike was prepared by the Department of Highways, that it was gotten together without a definite set of engineering standards which eventually were to be incorporated. Briefly, the estimate was prepared on a basis of four 11-ft. lanes—two of concrete—two of a flexible type bituminous surface with a 10-ft. medial strip, and 10-ft. shoulders; structures carrying the Turnpike were calculated on the basis of a 44-ft. roadway, and it was anticipated that a great portion of the intersecting roads would be abandoned or relocated in order that the number of structures along the line of the Turnpike would be kept to a minimum. In fact, it was calculated that there would be ninety-seven structures required for carrying the Turnpike across intersecting roads. In these early days preparation of estimates after discussions with automotive manufacturers, a study of the rugged terrain through which the highway must pass, and a balancing of economics, a maximum 3 per cent grade was set, likewise, a maximum curvature of 6 degrees; there were to be no intersections at grade. Eight tunnels would be required in order to maintain the 3 per cent grade through the Appalachian Range.

From actual surveys, cross-sections, and the generous use of United States Geological Survey maps, excavation quantities were estimated (which afterwards proved to be remarkably accurate) at twenty million cubic yards. The estimate presented to the Pennsylvania Turnpike Commission by the Pennsylvania Department of Highways indicated a total cost of approximately $44,000,000 to which, necessarily, was added estimated amounts for land acquisition, legal and administrative work, engineering, bond discount, and interest during construction. Recommendations to the commission were that three years would be necessary for the completion of the Turnpike in accordance with the estimate submitted.

Financing

Concurrent with the submission of the cost estimate, Parsons, Klapp, Brinckerhoff and Douglas submitted their report as to the estimated traffic probabilities and the earnings to be expected therefrom. A review of the total cost of the Turnpike, set up against the consulting engineer's traffic report, indicated that the Turnpike was an entirely feasible financial proposition and banking interests were immediately contacted by the commission for the sale and purchase of Pennsylvania Turnpike bonds. After extensive conferences and negotiations for the sale of $61,000,000 worth of these bonds to private bankers, it was found impractical to finance the entire cost through private banking interests.

The commission next applied to the federal government for aid in financing their bond issue and received a WPA allocation of approximately $24,000,000 for WPA labor; with this as a back-log, discussions were again held with bankers, but wtihout success.

When the 1938 session of Congress met in Washington, additional funds were allocated to the Public Works Administration and their functioning extended by an Act of Congress to June, 1940. Walter A. Jones, Chairman of the Pennsylvania Turnpike Commission immediately presented the factual data that had been assembled to the Public Works Administration and applied for a 45 per cent grant, and at the same time requested of the Reconstruction Finance Corporation that they purchase $35,000,000 worth of Turnpike bonds. The federal agencies granted the petition of the Pennsylvania Turnpike Commission and in the latter part of June, 1938, definite commitments were made to the Commission of the acceptance of their offer to the federal agencies involved, and the legal steps were immediately initiated by both PWA and RFC for the final culmination of the transaction. All documents were signed on October 10, 1938, and, for the first time since the Pennsylvania Turnpike Commission was in existence—they were in funds.

During the preliminary stages of the design it was necessary that extreme care be exercised in the expenditure of funds by the state highway department. Under the Act, all expenditures were to be repaid by the commission from the sale of bonds. At the time when the grant agreement and the trust indenture were signed by the commission and the Secretary of Highways, the engineering, administrative, and legal staff of the commission consisted of approximately 160 employees.

Plans and Controls

On October 10, 1938, when funds became available to the commission not a single construction plan had been completed, yet, on October 14, a section ten miles in length for grading and drainage work in Cumberland County was advertised for bids. The contract was awarded October 26, and construction started on October 27. The design period was now well under way. The controlling factors in the formation of the principles used throughout the construction are as follows:

1. The entire 160 miles had to be completed on May 1, 1940; this date being subsequently advanced to June 28, 1940.
2. A very definite amount of money; namely, $61,000,000 was all that was available for the construction and financing and for putting the Turnpike into paying operation.
3. The Act definitely fixed the termini, namely, Middlesex in Cumberland County and Irwin in Westmoreland County.
4. Grades were limited to not more than 3 per cent and curves not in excess of 6 degrees. The alignment was controlled by the two termini and sixteen tunnel portals.
5. No existing state highway or township roads could be utilized.

When this stage of the life of the Turnpike had been reached the attitude of the engineering and financial world changed. Prior to the governmental financing few persons paid the slightest attention to the engineering work that had been done, and that was being carried out by the Turnpike engineering staff. As soon as the financing was completed the commission was besieged with offers of aid and suggestions for design, methods, and procedure that was entirely missing in the past—all of this proffered aid being made without a proper understanding of the facts that had transpired prior to this time. Recalling the statements about when the original estimate was made, it will be noted that the completion time had been cut from an estimated and predicted 3 years to 20 months.

In October, 1938, the engineering staff was comprised of a few individuals trained in highway work and pro-

Interest in the Pennsylvania Turnpike project was nationwide, as indicated by the demands for the October, 1939, issue of Roads and Streets. Thousands of extra copies (requiring extra press runs) of the issue were requested. For that reason, we decided to complete the technical explanation of the project in this issue, special emphasis being given to the two major items—paving and tunnels.

These articles are particularly good and, coupled with the design and grading as explained in the October issue, constitute the best, most complete technical discussion of the engineering and construction features of this great superhighway.—Editor

cedure. No duties were specifically assigned to the various members of its staff. One year later the engineering organization totaled well over 1100 trained men and women and was in fact the fastest moving, hardest hitting, engineering organization ever developed in the history of road building.

Work was started on the plans on October 10, 1938, and on July 7, 1939—nine months later—the entire Turnpike line, 160 miles in length, 7 tunnels, 300 structures, (some quite major in character) were advertised for bids and were under contract. Standards had been developed that far exceeded those originally contemplated; roadway width had increased from four 11-ft. lanes to four 12-ft. lanes—all being of 9-in. uniform thickness of concrete rather than that originally contemplated. Structures carrying the Turnpike, with the exception of three cases which involved major structures and viaducts, were carried full roadway widths. Center piers of structures crossing the Turnpike overhead had been eliminated in so far as it was economically possible; the structures originally totaling approximately 180 had increased to 300 and, last of all, but certainly not the least—approving agencies had entered the engineering picture. Some of the approving agencies are the Pennsylvania Department of Highways, the PWA, the RFC, the consulting engineers for the financial interests who had purchased $10,000,000 worth of bonds from the Reconstruction Finance Corporation, the Pennsylvania Department of Labor and Industry, the Pennsylvania Department of Health, and the Pennsylvania Art Commission. Anyone having had experience with obtaining approval of these various state and federal agencies will, in a measure, readily understand the annoying complications that beset the engineering personnel.

1939 Construction Period

In the early part of July, 1939, when the last miles of Turnpike had been placed under construction, work stepped into what is called the second phase—the construction period. Many reasons were given as to why the program could not be accomplished. However, the initial phases were accomplished, and in the face of being labeled as an "impossible schedule." Such accomplishments could not have been obtained were it not for the wholehearted and thorough cooperation of every member of the commission personnel and the will-to-do on the part of some very excellently equipped and trained contractors. That difficulties were encountered is understandable. That changes in plans and that adjustments here and there, were necessary is also understandable. "That nothing shall be permitted to stop work," was an instruction from the chairman, which was never violated.

Analyzing the cost figures of the Turnpike as being constructed and as first conceived indicates a remarkable degree of accuracy in estimates and controls. However, an additional grant of $8,950,000 was made to the Pennsylvania Turnpike Commission by PWA and RFC, which was necessary to insure a complete and operating highway.

In a measure this additional money was required for the following unforeseen items:

1. Unexpected right of way costs.
2. Required speed of the project, occasioned by federal law.
3. Interpretation of the Brumbaugh Act of 1915.
4. Equipment requirements placed in contract documents.
5. Changing from dual type paving to all concrete.
6. Lack of sufficient time to procure relocations and vacations of township roads, resulting in serious increases in number of roadway structures.
7. Effect of European war conditions.

Acquisition of 160 miles of right-of-way across the state is one feature that is worthy of comment at this time. It is difficult for one to conceive of the many personal and legal entanglements that had to be solved and appeased before construction could start on the land—that is now owned. The commission paid $2,000,000 to the Pennsylvania and the B. & O. Railroads for the old South Penn right-of-way in order to acquire the tunnels necessary to maintain grade limitations.

BOOK REVIEW

PROCEEDINGS OF THE EIGHTEENTH ANNUAL MEETING OF HIGHWAY RESEARCH BOARD

PART II.—SOIL MECHANICS AND SOIL STABILIZATION

For the greatest and most economical value to be obtained fro mteh use of soils in construction work, it is necessary that their fundamental characteristics be understood and that procedures be established to measure the several characteristics. Tests have been developed for identifying physical and chemical characteristics of the heterogeneous groups of soils. These tests are uniform and have been standardized. With this as a beginning, long strides have been made in the controlled employment of soils. Research has been the foundation stone of these accomplishments.

The papers and reports have now been published by the Highway Research Board and are available as a bound book. They may be obtained from the Board offices at Washington, D. C., for $2.25 per copy. Included is a compendium on soil testing apparatus conducted by the Department of Soils Investigations with the assistance of the U. S. Bureau of Public Roads.

MAINTENANCE DISTRICTS AND FACILITIES

By E. J. KINNEY
Engineer of Design and Specifications, Pennsylvania Turnpike Commission.

MAINTENANCE and snow removal activities, including sanding and cindering, on the Turnpike is second in importance only to that of the actual construction of the project. Due to the many operating accessories, maintenance presents many operations foreign to the maintenance of an ordinary highway system. In fact, highway maintenance engineers have not been confronted with numerous problems that will develop.

To better illustrate the unique problems that are arising from a study of the necessary maintenance organization and facilities that will be required, it is well to bear in mind that the Turnpike is a project definite in length, that there are no grade crossings with other highways or with railroads, that there are no traffic lights, that there are 7 vehicular tunnels, that there are approximately 106 miles of plate guard fence which is being erected on steel posts, and that the right-of-way will be fenced with several types of fencing ranging from the chain link type to two strands of plain wire. The road bed of the Turnpike has been cut through hills and in numerous locations the depths of cuts ranges from 50 to 100 ft. with a maximum of approximately 150 ft. in depth for a distance of approximately 2,400 ft. in length. One side hill cut approximately 250 ft. in depth is involved. These great depths of cuts will undoubtedly increase the required maintenance of the slopes and berms and will present a very difficult problem in removing the snow from those sections in order that adequate storage space may be provided for additional snowfalls.

From the foregoing it will be readily noted that many new problems are in the offing for the maintenance engineers who will supervise the maintenance and snow removal activities, particularly in view of the fact that the traveling public will be paying for the use of the Turnpike and therefore will rightfully expect that extraordinary services will be rendered to them.

Snow removal will require a competent organization equipped with powerful motor truck plows and rotary snow plows, as the Turnpike traverses a snow belt in Pennsylvania which has for years been recognized by the highway department as one of the most difficult areas during snow periods.

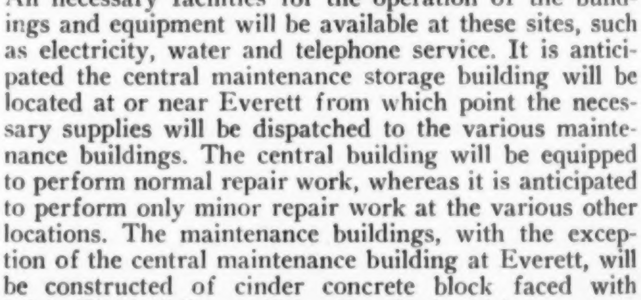
Maintenance storage buildings will be so located that motorized equipment can be speedily dispatched to a given section. Each will be assigned a patrol mileage ranging from 22 to 33 miles. The location of the building in each section will be approximately at the center, however, other important considerations vary this condition in order to better facilitate the operation within that section, such as accessibility to grade separation structures, and locations close to heavy snow areas. The sections further have been predicated upon locations that will not require the operation of snow plows through the tunnels, however, this latter condition could not be carried out for all tunnels due to the short distances between several of them.

As a result of the studies it was determined to locate the buildings at the following points along and adjacent to the Turnpike:

(1) Donegal, south of the interchange.
(2) Somerset, Somerset Township, approximately 3½ miles east of the Somerset interchange.
(3) Kegg, Juniata Township, Bedford County, in a heavy snow area.
(4) The central building at or near Everett.
(5) Burnt Cabins, just west of the Tuscarora tunnel approach.
(6) Newville, west upper Frankford Township, Cumberland County.

The locations at Donegal, Everett and Burnt Cabins are adjacent to highway grade separation structures, which will be utilized by the Turnpike equipment to avoid the necessity of crossing opposite travel lanes. All necessary facilities for the operation of the buildings and equipment will be available at these sites, such as electricity, water and telephone service. It is anticipated the central maintenance storage building will be located at or near Everett from which point the necessary supplies will be dispatched to the various maintenance buildings. The central building will be equipped to perform normal repair work, whereas it is anticipated to perform only minor repair work at the various other locations. The maintenance buildings, with the exception of the central maintenance building at Everett, will be constructed of cinder concrete block faced with brick. The buildings will be 40 x 80 ft. with a separate office and heater room.

The various regular maintenance activities will be handled from the several maintenance buildings and it is planned to provide a small tool box mounted on a trailer to transport the hand tools from the building to the site of work. It is believed that this method will greatly reduce the loss of tools, reduce the inventory of tools and eliminate the necessity of placing small tool boxes along the right-of-way. It will further provide for a more flexible working arrangement. Special trucks will be equipped to provide for electrical and mechanical repairs that might be required from time to time in the tunnels, portal and interchange buildings.



Andrews and Andrews Operate 34E Double Drum and 27E Single Drum Pavers in Tandem; East of Alleghany Tunnel

TURNPIKE TUNNELS HOLED THROUGH

Detailed Data, Construction Procedure and Special Features Discussed

By WILLIAM F. GOULD
Central Office Engineer, Tunnels, Pennsylvania Turnpike Commission

TRAVELING west along the Turnpike from its eastern terminus, the seven tunnels are Blue Mountain, Kittatinny Mountain, Tuscarora Mountain, Sideling Hill, Ray's Hill, Allegheny Mountain and Laurel Hill. For a plan location of these see the October, 1939, issue of ROADS AND STREETS. All of these except Allegheny Mountain tunnel are in the same locations as the original tunnels started more than 50 years ago. Allegheny Mountain tunnel is being constructed and is about completed at a location 85 ft. south of and approximately parallel to the old tunnel.

Upon completion of accurate line and cross section surveys of existing conditions in and about the old tunnels (a double track section, Blue Mountain, is shown by Figure 1) and extensive geological surveys, various alignments were studied by superimposing the final cross section of the vehicular tunnel upon the plotted cross sections of the old tunnels to determine the most economical use of the old work and the final alignment of the new project. Figures 2, 3 and 4 show typical examples of the relation between old and new sections.

Fig. 1—Existing Condition of Blue Mountain Tunnel, a Double Track Bore, When Construction Started on the New Tunnel

Typical Cross Section

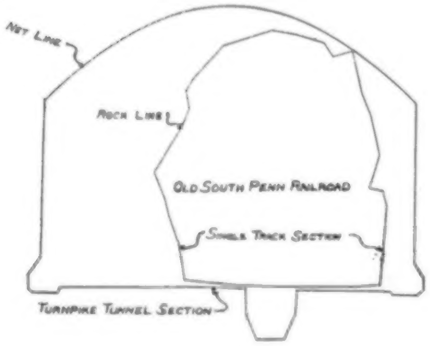
The typical tunnel cross section, shown on Page 72, October, 1939, issue of ROADS AND STREETS, provides for a fresh air duct between the arch and ceiling for the ventilation system, the ceiling being a thin slab supported at its midpoint by stainless steel hangers; a two lane 10 in. reinforced concrete roadway 23 ft. in width between curbs with a minimum of 14 ft. 4 in. of overhead height; a sidewalk on one side 2 ft. 10 in. wide; a ledge on each side forming the encasement for the low tension electrical ducts carrying the control, signal and communication cables; a bank of high tension ducts under the sidewalk carrying power cables for ventilation equipment; a longitudinal center drainage gallery fed by transverse french drains, spaced approximately on 30 ft. centers, connected to longitudinal french drains immediately behind and at the bottom of the sidewalls, and a water line for flushing and fire purposes suspended from the roof of the longitudinal drainage gallery. The tunnels are lighted by mercury vapor lamps located in the tunnel ceiling. In the event of failure in this system, an emergency lighting system using incandescent lamps located in the sidewall covers below the tunnel ceiling is automatically put into service. Ventilation for the tunnels is furnished by fans installed in ventilation building located directly over both portals of all tunnels except Ray's Hill tunnel which has only one ventilation building.

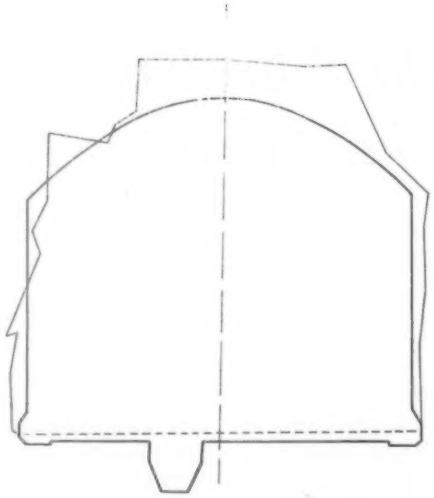
The structural design of the typical tunnel cross section was varied to suit special conditions which were known to exist when the contract drawings for the various tunnels were prepared. For instance, the roofs of several of these tunnels which were not supported when being excavated 50 years ago, have fallen due to the air slacking of the material penetrated and have created voids above the final Turnpike tunnel template varying in height from a few feet to 40 ft. The design of tunnel to be constructed through these areas and the treatment of the falls were shown on the original contract drawings. Provisions were made on the original contract drawings for the installation of steel plate tunnel lining to protect the concrete lining from the action of acid waters. Investigations revealed that the pH values of water encountered in various locations varied from 3.2, a high relative acidity, to 8.8, a high relative alkalinity. In some cases the concrete arch was thickened in order to support heavy loads of rock fill to be placed in the voids above the arch. Provisions were made for the use of heavy timber ribs and steel arch ribs where roof conditions required support prior to the concreting operation.

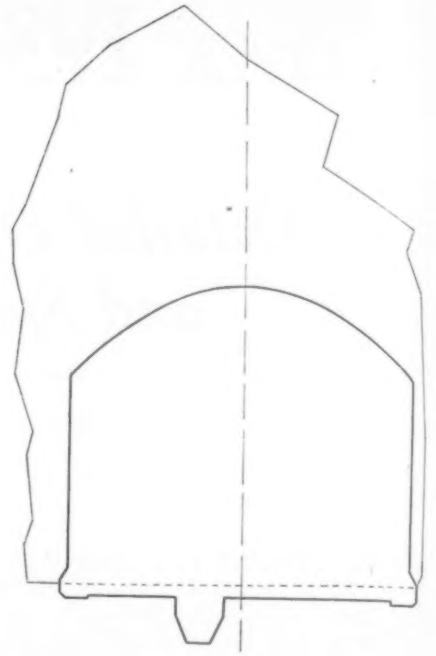
Fig. 2—Showing Relationship in Cross-section Between Typical Abandoned Single Track Tunnel Work and the Turnpike Cross-section

Fig. 3—Typical Relation Between Double Track Driven Section of Old Tunnel to Turnpike Tunnel Section

Fig. 4—Typical Relation in a High Fall Area Between Existing Old Tunnel and the Turnpike Section







Construction Procedure

Most of the tunnel contractors chose to remove the excavation required for the ventilation buildings prior to the starting of actual tunnel driving. While this work was progressing the grading of the approaches was going forward.

Actual driving started on the first tunnel contract in June, 1939, and the excavation in all of the tunnels was completed in the early part of May, 1940.

The method of excavation adopted by all the tunnel contractors was in general the same. The contractor on Allegheny Mountain Tunnel started his excavation by using the bench and heading method which was abandoned after a trial for the faster and more economical method of full face. The contractor on Laurel Hill Tunnel excavated full face in one heading and in the other heading he used the bench and heading method. All of the other tunnels were excavated full face and from both ends.

The boring of tunnels consists of the continuous repetition of a cycle of drilling, blasting, and mucking. The frequency of such cycle is dependent upon the character of the material being penetrated, water conditions, and the necessity for roof support.

Drilling and Shooting.—The number of holes drilled for full face tunneling varied from 60 to 160 depending upon the nature of the rock being penetrated. The length of tunnel to be removed in the cycle varied from 6 ft. to 13 ft., depending again upon the quality of the material being penetrated, and whether large overbreakage was likely to occur or whether support was necessary. To underbreak a round causes considerable expense to a contractor for trimming, and large overbreakage is an expense to him as usually no compensation is received for the concrete placed in the lining outside of fixed lines indicated on the drawings. The amount of explosive required for a round varied between 3 and 4 lbs. per cubic yard of rock, or in other words, an average round of 10 ft. required from 800 to 1,100 lbs. The explosive used was generally a 40 per cent gelatin powder. Some of the contractors used 60 per cent gelatin powder in the lifter holes and in the bottom cut holes.

A typical cycle in hard gray sand stone consisted of the drilling of approximately 155 holes requiring six hours time with 12 drills. Using 735 lbs. of explosive, 10 lin. ft. of tunnel was pulled approximately 240 cubic yards of excavation. The removal from the tunnel of the material blasted required approximately 6 hours. A typical cycle in soft red or gray shale required the drilling of 96 holes over a period of approximately 2 hours using 10 drills. Using 700 lbs. of explosive, approximately the same length of tunnel was pulled. Four hours and fifteen minutes were required for the removal from the tunnel of the blasted material. These cycles were typical in the new Allegheny Mountain Tunnel. The contractor excavated 660 lin. ft. of tunnel during the month of November; 570 lin. ft. in December; 1,110 lin. ft. during January; 1,300 lin. ft. during February; and 1,485 lin. ft. during the month of March to complete the tunnel excavation. The average daily progress on the enlarging of previously driven sections of the other tunnels varied from 11.3 lin. ft. of tunnel to 35.7 lin. ft., the daily average being 23.2 lin. ft. In the undriven portions of the other tunnels, the average daily progress varied from 11 lin. ft. to 35.5 lin. ft. or an average on all tunnels of 18.6 lin. ft.

Mucking.—The drilling equipment used on some of the tunnels was mounted on jumbos riding on rails at a wide gauge, 20 ft., to permit the free movement of mucking equipment below it. During the blasting operations, this gantry was moved along the rails away from the face. Other tunnels used dual drilling jumbos with folding platforms mounted on old trucks. During the blasting operations, the side platforms were folded and the trucks were driven away from the face and parked one behind the other along the side of the tunnel, allowing free way for mucking trucks to pass. In the bench and heading operations at Laurel Hill Tunnel, the contractor used a small jumbo on a flat car for drilling the upper half of the tunnel. This operation was followed by the drilling and blasting of the lower half or bench which was in turn followed by the mucking operation. Muck haulage in three of the tunnels as shown by Table I, was by narrow gauge dump cars pulled by either electric or diesel operated locomotives. The other four tunnels used diesel operated trucks, dumptors, or tractors and crawler wagons.

TABLE I—TYPES OF PRINCIPAL EQUIPMENT USED IN TUNNELS

Contract Number	Jumboes	Driling Bits	Mucking	Hauling	Concrete Placing
12	2 Truck mounted, steel pipe	*Solid steel up to 15 ft.	Cut back shovels, elec.	Crawler wagons, then trucks (diesel)	Presweld Pneumatic
13	Truck mounted, steel frame, then rail mounted	Solid steel up to 18 ft.	Conway mucker, then cut back shovels, elec.	Locomotives (diesel) Dump cars	Pumpcrete Force pump
17	Truck mounted, then rail mounted	Detachable	Conway mucker, then cut back shovels, elec.	Crawler wagons, then battery locomotives Dump cars	Presweld Pneumatic
18	Rail mounted	Forged bits with steel 18 ft. long, detachable 14 ft. steel	Cut back shovels, diesel, elec.	Locomotives Battery—inside Battery—outside Dump cars Dumptors, diesel	Presweld Pneumatic
24	Rail mounted		Cut back shovel, elec.	Dumptors	Presweld Pneumatic
25	Truck mounted, wooden	Solid steel, 12 ft.	Cut back shovels, elec.	Trucks, diesel	Pumpcrete Force pump

* All automatic feed drifters.

Silicosis Prevention. — Ventilation during excavation operations was provided by blower fans of sufficient capacity to maintain a concentration under 100,000,000 particles of dust, under 10 microns in size, per cubic foot of air when drilling in rock containing less than 10 per cent by weight of free silicon dioxide, and under a concentration of 10,000,000 silicon dust particles per cubic foot of air when drilling in rock having a free silicon dioxide content of 10 per cent or more by weight. Some of the ventilation units were capable of both blowing and exhausting, the exhausting being used immediately following the blasting operation. The ventilation pipe used in all tunnels except Sideling Hill Tunnel was of the spiral riveted steel type. In Sideling Hill tunnel the contractor constructed the drainage gallery as he excavated and used the gallery for both drainage and ventilation.

Steel and Drifters.—Wet drilling was required and was used in all tunnels, the drills having a center hole not less than 3/16 in. in diameter through which a continuous flow of water was maintained while the drill was in operation. The water valves were of the type having only two fixed positions, closed and completely open. The minimum rate of water flow through hand drills having a maximum piston bore of 3 in. was 0.75 gal. per minute, and the maximum rate of air flow through such drills at half speed was 1.0 cu. ft. per minute. Where drifter-mounted and wagon-mounted drills having a maximum piston bore of 4 in. were used, normal full speed operation required from 0.75 to 1.5 gal. of water per minute and from 2 to 4 cu. ft. of air per minute through the drill. Detachable bits on steel lengths up to 14 ft. were used by some contractors. Others used solid steel bits up to 18 ft. in length. All contractors used automatic feed drifters.

During the drilling operations, the contractors were required to maintain the rock surfaces in a damp condition for a distance of at least 30 ft. from the heading.

Lining Operations

Wall and Arch Steel.—The steel used for supports in the various tunnels ranged from 6 in. I-beams weighing 12.5 lb. per linear foot to 8 in. wide flanged beams weighing 40 pounds per linear foot. The spacing of the ribs varied from 2 ft. to 8 ft. on centers, depending upon the type of material being supported. The ribs and posts were tied together with tie rods spaced on 5 ft. centers and were held apart with wooden spreaders. The most usual type of arch rib used consisted of 8 in. wide flanged beams weighing 31 lb. per linear foot for the arch, supported on two 8 in. wide flanged posts weighing 24 lb. per linear foot. The arch was fabricated in two sections and was peaked in the middle to allow the concrete pipe to be placed between the ribs and arch form.

Fig. 5—View Showing Erection of Tunnel Ribs in Sideling Hill Tunnel

Concreting.—Generally, the concrete lining of the tunnels was placed against rock. In those places where overbreakage above the arch either existed prior to operations under the contracts or were overbroken during excavation under the contracts, lagging and supports were placed, above which the voids were filled with concrete, stone, stone chips, or granulated slag. Where overbroken spaces outside of the sidewalls existed or were caused by the contractors' operations, lagging supported on vertical beams was provided and stone fill placed prior to the concreting of the sidewalls. Where "high falls" existed above the roof template prior to operations, special treatment had to be provided depending upon the nature of the rock and the possibilities of additional falls. It was originally planned that the high voids would be supported with protected timber or with concrete diaphragm walls, as

shown by Figure 6, resting on the concrete tunnel arch. Payment was made to the contractor for this work under appropriate unit prices. Where "high falls" were caused by the contractor's operations, these methods of treatment or equal methods could be used at the contractor's option as no payment was made for such work. Except in one case, the actual construction used in the large voids, the sides and roofs of which were in extremely dangerous condition, consisted of timber cribbing supported on the steel arch ribs. After the concrete tunnel lining was placed, the voids were completely filled with stone chips or granulated slag either pumped or

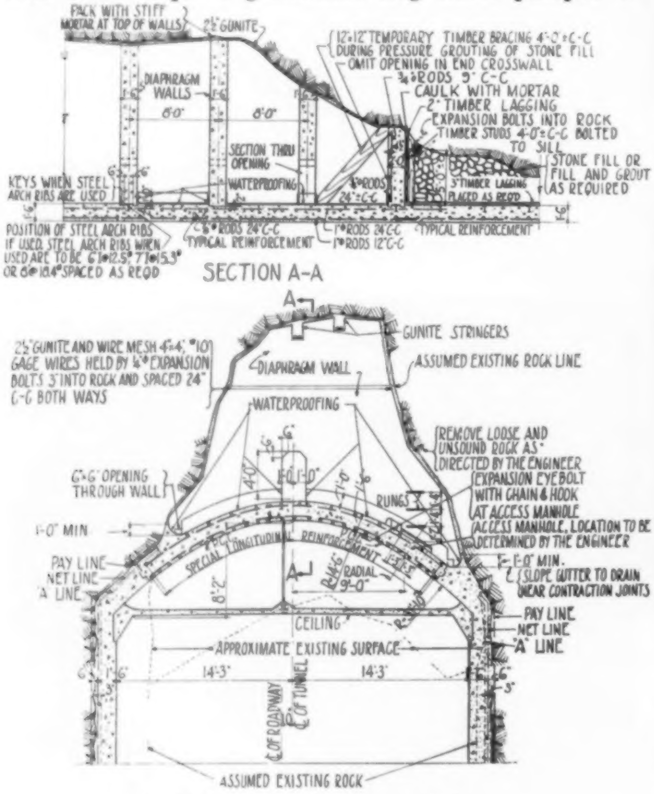


Fig. 6—Special Treatment Using Diaphragm Walls for "High Fall" Support

blown into place, depending upon the type of equipment which the contractor was using for his concreting operation. In the one exception to this treatment, diaphragm wall construction was used, substituting precast concrete blocks for concrete cast in place. The void was not filled.

The contractors on Tuscarora Mountain Tunnel and Sideling Hill Tunnel are using pumping equipment for placing concrete. The contractors on all of the other tunnels are using pneumatic placing equipment.

The first concreting operation is the placing of sidewall footers, the tops of which are below the pavement grade. Next follows the sidewalls up to the longitudinal construction joint above the ceiling in the arch. The tunnel arch is then placed, following which the ceiling is placed. These are illustrated by figures 7, 8 and 9. The normal length of tunnel panel is 30 ft. with a formed copper water stop in each vertical joint. Water stops are used in the arch only in wet locations. All ceiling joints have formed copper water stops and cork joint fillers. Sidewalls are being placed in panel lengths. The arch and ceiling are being placed in 30, 60 or 90 ft. lengths. The forms used are of the telescoping type and are of steel.

The concrete used on all tunnels has a water cement ratio of not more than 6 gal. of water per bag of cement. The average cement content was 1.65 bbl. per cubic yard. The coarse aggregates used for tunnel concrete was stocked in two sizes,—4 mesh to ¾ in. and ¾ in. to 1½ in.

The consistency of the concrete was determined by the resident engineer, such determinations being governed by the type of equipment used by the contractor and the placability of the concrete in the forms. Further, the mixtures of concrete were adjusted by the engineer from time to time to produce suitable workability. Internal mechanical vibration of concrete in

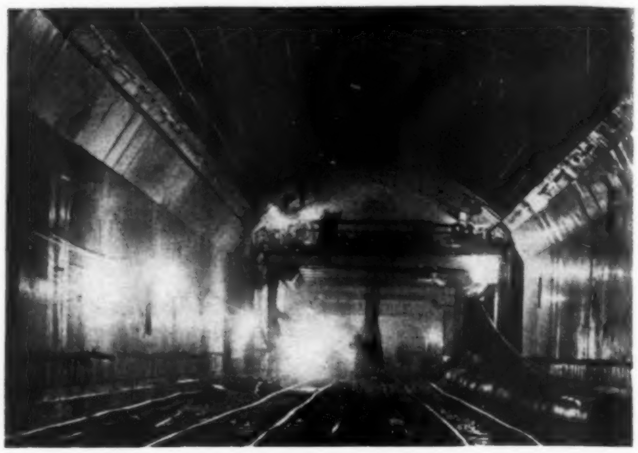


Fig. 7—Erecting Arch Forms. Completed Side Walls in Foreground. Allegheny Mountain Tunnel

Fig. 8—Completed Side Walls and Arch, Allegheny Mountain Tunnel

Fig. 9—Ceiling Slab in Sideling Hill Was Poured in Alternate 90 Ft. Sections. There Was Always One Section Open Between the Pouring Operations. Space Above Ceiling is Air Duct

sidewalls was required with high frequency vibrators having a minimum of 4,500 impulses per minute. In less accessible locations, compaction was obtained by the restricted use of form vibrators and spading.

The mixers used were all of the batch type, drum operation being at a peripheral speed of approximately 200 ft. per minute. After all materials were introduced into the mixers, a minimum of 1¼ minutes of mixing time was required for one-yard mixers and ¼ minute additional for each additional cubic yard or fraction thereof.

Forms.—Forms were required to remain in place on the tunnel sidewalls until such time as the concrete had attained an ultimate compressive strength of 400 pounds per square inch, determined by tests on cylinders made and cured under actual working conditions. The required ultimate compressive strength, determined in the same manner, of the concrete in the tunnel arch and ceiling slab were respectively 600 lb. per square inch and 1,500 lb. per square inch. The time required to obtain the foregoing strengths was determined upon completion of the placing of the first section of tunnel arch, sidewall, and ceiling. Any changes in the mix, mixing, concrete placing conditions and temperatures, or any of them, required the making of new tests.

Immediately upon removal of forms no treatment was given to the surfaces of the concrete except the rubbing down of ridges and fins to a plane surface. Honeycombed portions of surfaces exposed to view were cut out to the extent of the defects, and to a minimum depth of 5 in. The concrete replaced was of the same mix and material as that in the original concrete and was keyed or doweled into place.

All exposed concrete surfaces were kept completely and constantly wet for at least seven days after the concrete had been deposited.

Progress. — Actual concreting of sidewalls commenced in the early part of December. The progress of concreting of the sidewalls ranged from 30 lin. ft. of tunnel per day to 120 lin. ft. of tunnel per day. The daily average of all tunnels was 35.1 lin. ft. Arch and ceiling varied from 30 lin. ft. of tunnel per day to 180 lin. ft. per day. The daily average of arch concreting was 32.9 lin. ft. and ceiling 35.1 lin. ft. A maximum daily report from a tunnel would indicate that the sidewalls for lin. ft. of tunnel, 120 lin. ft. of arch and 180 lin. feet of tunnel ceiling were placed.

Sand Seam Treatment

One of the many problems which confronted the tunnel designers and the actual treatment of the situation during construction deserves mention.

When exploratory holes were being bored for design information in Kittatinny Mountain Tunnel, the horizontal borings between the existing headings entered a seam, approximately 10 ft. in width longitudinally of the tunnel, of very fine sand saturated with water. When the drill bits were withdrawn from this seam, approximately 500 cu. yd. of this sand and water mixture were deposited on the old tunnel floor before the hole could be plugged. Measurements indicated that this stream of material was under a 200 lb. per square inch pressure. The original tunnel section for this area was a doughnut shape, the hole conforming in shape to the tunnel interior, designed to withstand the pressure indicated and to span the width of seam plus the section

TABLE II.

PENNSYLVANIA TURNPIKE TUNNEL DATA	KITTATINNY MOUNTAIN TUNNEL	BLUE MOUNTAIN TUNNEL	TUSCARORA MOUNTAIN TUNNEL	SIDELING HILL TUNNEL	RAYS HILL TUNNEL	ALLEGHENY MOUNTAIN TUNNEL	LAUREL HILL TUNNEL	TOTALS - ALL TUNNELS
CONTRACT AND SECTION NUMBER	18 - KB2		25- T2	12 - S2	24 - R2	17 - A2A	13 - L2	
CONTRACTOR	BATES AND ROGERS CONSTRUCTION CORPORATION		B. PERINI AND SONS	THE ARUNDEL CORPORATION	MASON AND HANGER	GUTHRIE-MARSCH-PETERSON	HUNKIN-CONKEY CONST. CO.	
CONTRACTOR'S ENGINEER	J. W. MAXWELL		MR. PHILIPS	C. W. BLACK	H. L. KING	MR. KLEFF	A. E. LEE	
CONTRACTOR'S SUPERINTENDENT	D. R. AGNEW		A. LATTANZI	R. E. PARKER	C.G.McDOWELL	C.H.TAYLOR	W.M.BENNET	
COMMISSION RESIDENT ENGINEER	F. C. SELLNOW		K. C. BELLOWS	T. M. ROACH	E. A. MAY	C. A. BUDNIK	C, A. BUDNIK	
AMOUNT OF CONTRACT	$2,920,123.00		$2,055,939.67	$2,444,527.25	$1,549,718.50	$2,672,188.40	$1,920,281.48	$13,562,778.30
AMOUNT OF APPROACHES	$104,593.25		$251,990.60	$101,504.05	$132,551.00	$255,189.00	$341,788.10	$1,187,616.00
AMOUNT OF TUNNELS	$2,815,529.75		$1,803,949.07	$2,343,023.20	$1,417,167.50	$2,416,999.40	$1,578,493.38	$12,375,162.30
COST PER FOOT OF TUNNELS	$321.78		$338.67	$353.76	$417.06	$409.11	$361.36	
DATE CONSTRUCTION STARTED	JUNE 7,1939		JUNE 19,1939	APRIL 28,1939	JUNE 20,1939	JUN 19,1939	APR 27,1939	
LENGTH OF WEST APPROACH	1349.84'	320.00'	2678.33'	3523.33'	1582.00'	2861.00'	2031.00'	14,345.50'
LENGTH OF WEST OPEN CUT TUNNEL	79.76'	80.06'	79.63'	76.91'	89.00'	81.00'	94.00'	580.36'
LENGTH OF DOUBLE TRACK-WEST PREVIOUSLY DRIVEN SECT.	932.24'	233.00'	932.24'	412.09'	368.00'		408.22'	3,285.79'
LENGTH OF SINGLE TRACK-WEST PREVIOUSLY DRIVEN SECT.	713.95'	908.00'	1068.50'	1160.00'	720.00'		404.78'	4,975.23'
LENGTH OF UNDRIVEN SECTION	550.97'	1173.80'	1452.50'	3379.00'	1001.00'		3555.13'	11,112.40'
LENGTH OF DOUBLE TRACK-EAST PREVIOUSLY DRIVEN SECT.	917.40'	1045.16'	840.80'	546.00'	460.00'			3,809.36'
LENGTH OF SINGLE TRACK-EAST PREVIOUSLY DRIVEN SECT.	1457.12'	817.60'	1089.00'	1126.00'	850.00'			5,339.72'
LENGTH OF EAST OPEN CUT TUNNEL	75.56'	80.84'	79.70'	82.00'	24.00'	81.05'	78.87'	502.02'
LENGTH OF EAST APPROACH	320.00'	1439.00'	2340.50'	3007.32'	1914.27'	905.00'	6046.10'	15,972.19'
LENGTH OF TUNNEL BETWEEN ROCK PORTALS	4571.68'	4178.10'	5167.17'	6623.09'	3398.00'	5907.95'	4368.13'	30,214.12'
LENGTH OF TUNNEL BETWEEN FINISHED PORTALS	4727.00'	4339.00'	5326.50'	6782.00'	3511.00'	6070.00'	4541.00'	35,296.50'
LENGTH OF CONTRACT	6396.84'	6098.00'	10345.33'	13312.65'	7007.27'	9836.00'	12618.10'	65,614.19'
EXCAVATION								
AVERAGE DAILY PROGRESS-PREVIOUSLY DRIVEN SECT	26.7'	11.3'	29.5'	35.7'	20.8'		15.3'	23.2 AVG.
PREVIOUSLY DRIVEN SECTION COMPLETED-EAST	FEB 2, 1940	FEB 5, 1940	DEC 17, 1939	DEC 8, 1939	NOV 25,1939			
PREVIOUSLY DRIVEN SECTION COMPLETED-WEST	JAN 13,1940	DEC 10,1939	FEB 9,1940	DEC 6, 1939	JAN 12, 1940		AUG 4, 1939	
AVERAGE DAILY PROGRESS - UNDRIVEN SECTION	11.1'	11.0'	13.7'	29.7'	17.0'	35.5'	12.5'	18.6 AVG.
DATE TUNNEL HOLED THROUGH	APR 6, 1940	MAR 27,1940	APR 1, 1940	MAR 28, 1940	JAN 22,1940	APR 2, 1940	MAR 7,1940	
VOLUME OF EXCAVATION-PREVIOUSLY DRIVEN SECTIONS	75,000 cu yds		36,740 cu yds	31,200 cu yds	25,200 cu yds		8,270 cu yds	176,410 cu yds
VOLUME OF EXCAVATION-UNDRIVEN SECTION	43,000 cu yds		40,090 cu yds	93,000 cu yds	27,650 cu yds	162,500 cu yds	98,200 cu yds	464,440 cu yds
CONCRETE								
AVERAGE DAILY PROGRESS IN SIDEWALLS	20.2'	25.4'	28.5'	40.0'	33.2'	55.5'	42.9'	35.1' AVG
AVERAGE DAILY PROGRESS IN ARCH	32.4'	23.0'	27.7'	49.7'	29.4'	63.8'	54.4'	32.9' AVG.
AVERAGE DAILY PROGRESS IN CEILING	28.1'	24.1'	33.9'	66.0'	27.6'	53.1'	13.5'	35.1' AVG.
TOTAL VOLUME OF CONCRETE-SIDEWALLS, ARCH & CEILING	52,910 cu yds		28,760 cy yds	38,000 cu yds	19,150 cu yds	32,850 cu yds	24,830 cu yds	196,500 cu yds

PREPARED BY J.M.DIXON, DESIGNER DRAFTSMAN

of material penetrated shown by the borings to be a sugary standstone.

During construction the contractor chose to drive a full face heading to within a few feet of the point indicated by the original core borings as being the face of the seam. Driving operations were stopped and several core borings were taken by the contractor in order to explore the seam thoroughly. With the information from these borings, a model of the region was constructed from which driving operations were planned.

A pilot hole 3 ft. in diameter was first driven into the sand seam at the top of the tunnel. When holed through, approximately 1,000 cu. yd. of sand was released into the tunnel. The opening of the seam relieved all hydrostatic pressure and emptied the overhead portion of a pocket approximately 20 ft. in diameter and 75 ft. high, the bottom of which is apparently slightly below the tunnel floor. Following this a diagonal drift running from the driven tunnel roof up to the upper portion of the void was driven for observation purposes.

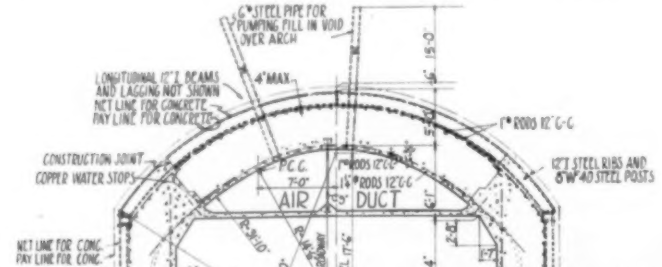


Fig. 10—Final Design of Tunnel Section in Sand Seam Area of Kittatinny Mountain Tunnel

Wall plate drifts approximately 8 ft. square were driven between the 2 headings. On completion of these drifts, 8-in. double channel wall plates were set and blocked to line. Excavation of a top heading and the installation of 8 in. 40 lb. I-beam arch ribs started from both headings until the area of the sand seam proper was reached. Because of danger from falling material in this opening, 12 in. I-beam spaced about 18 inches on centers were needled longitudinally across the opening above the arch ribs, the ends resting on the 8 in. 40 lb. arch ribs previously placed. Immediately after these longitudinal beams were placed, cord wood and scrap lumber were thrown over them from the diagonal observation drift. This lumber was placed to form a cushion to break the impact of falling material on these longitudinal ribs prior to the placing of the transverse arch ribs supported on the wall plates. Upon completion of these operations, the bench between the headings was removed by the usual method of drilling and blasting. Where the rock sidewalls and the ledges supporting the wall plates were found to be unsatisfactory material, they were removed and steel posts placed. At the time this article was prepared, construction in this area has reached this stage. The most difficult part of the excavation in this area has been completed, the remaining portion being similar to normal operations.

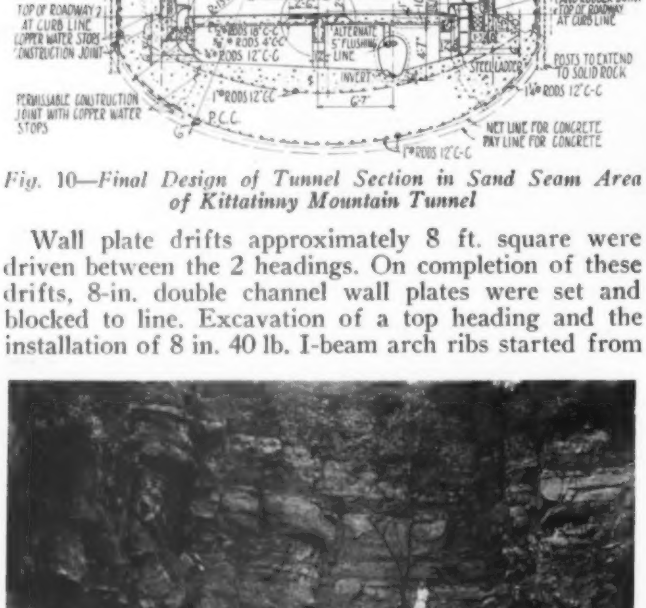


Fig. 11—Condition of East Portal of Old Laurel Hill Tunnel After 50 Years

While the final preparations were being made to carry out the plan of procedure formulated by the contractor, the commission engineers redesigned the special tunnel section in order that it might be more adaptable to the actual conditions encountered and its construction would fit the contractor's plan of operation.

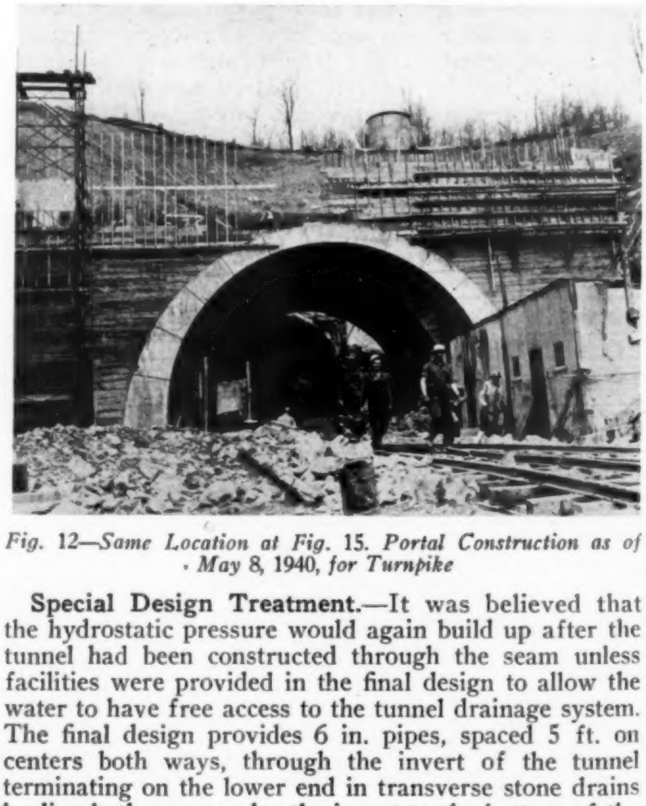


Fig. 12—Same Location at Fig. 15. Portal Construction as of May 8, 1940, for Turnpike

Special Design Treatment.—It was believed that the hydrostatic pressure would again build up after the tunnel had been constructed through the seam unless facilities were provided in the final design to allow the water to have free access to the tunnel drainage system. The final design provides 6 in. pipes, spaced 5 ft. on centers both ways, through the invert of the tunnel terminating on the lower end in transverse stone drains leading both ways under the invert to the bottom of the sidewalls. The cross section of the tunnel was designed to withstand a hydrostatic pressure equally as great as that originally encountered in the event that the intake pipes should become clogged. Upon completion of the tunnel through the region, a 15 or 20 ft. cushion of granulated slag will be placed in the void over the arch. Figure 10 shows the final design of the structure to be constructed in this area. The excessive thickness of invert shown on the drawing was not required structurally, but such a design will eliminate a few of the many difficulties of construction which confront the contractor in this area.

PLANNING PAVER EQUIPMENT REQUIREMENTS

Calculations Indicate Paving Outfits Necessary to Complete Turnpike Surfacing on Schedule

By ROGER B. STONE

Chief Construction Engineer, Pennsylvania Turnpike Commission

SOLVING the problem of equipment requirements for the paving program of 1940 on the Pennsylvania Turnpike was similar to the procedure followed very often by school children in working their mathematics problems in the grade schools, i.e., by turning to the back of the book for the answer and working backwards. At the close of paving work for 1939, statistical data became available from which to calculate job efficiencies and possible output. The answer to the problem was given in that it was known definitely how many feet or square yards of paving had to be in place and on what date.

It was known that 4,360,000 sq. yds. had to be placed and the completion date was set for June 22, 1940. During the fall of 1939, 354,797 sq. yds. were placed, leaving a balance of 4,005,203 sq. yds. for 1940. The first step in finding out how many paving mixers would be required, is an analyses of what was accomplished last fall. The tables given herewith present a comprehensive picture of 1939 operations and indicate what may be expected for 1940. Some exceptions have been taken to the findings on which anticipated outputs were calculated for the year 1940 as shown in Table VA. Lacking other information, anticipated outputs must be governed by the results obtained last year. The average efficiency rating of 72.7 per cent agrees very closely with the rating resulting from paving operations in the State of Pennsylvania over a period of years. Batch outputs for last year are a matter of definite record. It is conceded that the anticipated outputs may be somewhat conservative. However, in view of the fact that a large percentage of paving in the spring of 1940 will be placed under conditions similar to last fall, and in further consideration of the number of paving units at work at that time, it appeared unlikely that fast schedules would be made.

One hundred per cent efficiency is impossible. Under the most favorable conditions, the rate of expectancy will probably not exceed 88 per cent. The difference is constituted in a loss of a probable 6 per cent because of mechanical failures, and a further loss of 6 per cent due to the human element. In this calculation, no factor of safety for unforeseen conditions has been allowed. Labor troubles, strikes, slides, or even war interference are not without a realm of probability. In fact, at this writing, the truck drivers on one paving job are out on strike.

Statistical Information

The first step in determining equipment requirements is to ascertain the relationship between calendar days and paving days on yardage already placed. This is shown by Table I.

In Table I, 80 paving days, or 34.8 per cent of the time available, were lost through, (a) inclement weather, (b) Sundays, (c) lack of material, (d) breakdowns, and (e) the 40 hour week.

Between April 15th, 1940, and June 22, 1940, the established paving period, there are 68 calendar days.

Applying the ratio determined above to this period gives 44 possible paving days. Pennsylvania's Department of Highways records for a number of years show 43 paving days for the same period. This record, however, cannot be applied as a constant to the Turnpike for 1940 construction, first because of the need for pressure, and second because of the development and use of new equipment. The probable working days are given in Table VI.

TABLE I—RELATIONSHIP OF PAVING DAYS TO CALENDAR DAYS

Contr. No.	Sq. Yds. Placed	Paving Width	Paver	Paving St.	Ended	Cal. Days	Pav. Days	%
A	259,580	12'	34E	8-17-39	11-27-39	103	76	73.8
B	10,200	12'	34E	10-18-39	11- 7-39	21	8	38.1
C	41,679	12'	34E	10- 4-39	11-10-39	39	29	74.3
D	16,334	24'	34E	10-20-39	11-13-39	25	13	52.0
E	20,859	12'	2-27E	10-17-39	11-15-39	30	18	60.0
F	5,715	12'	34E	11- 4-39	11-15-39	12	6	50.0
	354 367					230	150	Avg.65.2

Calculating efficiency on the time basis, the average indicated is 81.3 per cent as shown by Table II.

TABLE II—RECORD OF TIME CONSUMED

Contract No.	Sq. Yds. Placed	Possible Paving Hrs.	Possible Paving Min.	Actual Paving Hrs.	Actual Paving Min.	Efficiency on Time Basis
		34E Pavers				
C	41,679	198	00	149	44	75.6
D	16,334	99	40	67	45	67.9
F	5,715	39	43	28	18	71.3
A	177,031*	657	04	552	07	84.0
TOTAL	240,759	994	27	797	54	Avg.80.2
		27E Pavers				
E	20,859**	112	23	101	56	90.6
TOTAL	261,618	1106	50	899	50	81.3

**Two pavers. *Record incomplete.

The calculations are based on pavers because they are the key unit in production.

A calculation of job efficiency on a batch basis is shown by Table III.

TABLE III—BATCH RECORD

Contract No.	Actual Batches	Possible to Place	Theo* Batches Per Hour	Actual Batches per Hour	Batch Effi-ciency	Job Effi-ciency
			34 E Pavers			
C	7,816	11,880	60	54	90	65.8
D	3,265	5,980	60	48	80	54.6
F	1,048	2,382	60	37	61	44.0
A	32,809	39,424	60	59	98	83.2
Total	44,938	59,666	Avg. 60	Avg. 49.5	Avg. 82.3	Avg. 75.3
			27 E Pavers			
**E	4,956	8,994	80	48	60	55.1
Total	49,894	68,637	Avg. 64	Avg. 49.2	Avg. 77.8	Avg. 72.7

TABLE III-A—RECORD OF PAVEMENT PLACED

Contract No.	Pavement placed* per Actual Paving Hrs.	Possible to** Place Hourly	Placed per Possible Paving Hour
C	278.4	319.8	210.5
D	241.1	319.8	163.8
F	201.9	319.8	144.0
A	320.7	319.8	269.4
E	102.4	168.4	92.8

* Square yards placed divided by actual paving hours—Table II.
** Theoretical batches per hour times square yards per batch—Table III and V.
*** Square yards placed divided by possible paving hours—Table II. This column might be termed the "hourly expectancy."

Table IV is a record of paving delays and the causes thereof. The last column is based on total paving hours. It is the complement of Table II which shows the percentage deficiency based on possible hours per contract. The hours charged under "Time" is that lost through the 40-hour week.

Fig. 1—Two Pavers Working Tandem, 34E and 27E, on Job. Typical Tandem Operation.

By excellent supervision and management, it is possible to eliminate all delays except those created by breakdowns. And these can be kept to a minimum by maintaining repair organizations and by keeping parts on hand for most common breakages. The hours charged against miscellaneous were due to lack of materials, mesh, water, etc. Table IV does not include delays for which the contractor is not responsible, such as weather, moving over gaps, etc.

Fig. 2—Trucks Pile Up When Delays Occur. Speed of Construction Requires Ready Truck Supply.

Probable Expectations

The data given in Table IV were determined from actual quantities and daily paving records. The table is premised on actual average outputs per batch, with no allowance being made for low grades or other factors which might affect the results.

Based on possible maximum batches per hour, 40 for 27E pavers and 60 for 34E pavers, the probable output per hour for a 27E is 42.12 cu. yds. and for a 34E it is 80 cu. yds.

TABLE V—ACTUAL PAVING RESULTS AND FUTURE PROBABILITIES

Sq. Yds. per Batch		Cu. Yds. per Batch		Lin. Ft. per Batch 12' Width	
27E	4.21	27E	1.053	27E	3.16
34E	5.33	34E	1.333	34E	4.00

TABLE V-A—PROBABLE OUTPUTS

	1 Hour		6 Hours		7 Hours		8 Hours	
Paver	L.F.	S.Y.	L.F.	S.Y.	L.F.	S.Y.	L.F.	S.Y.
27E	91.9	122.4	551.4	734.04	643.3	856.8	735.2	979.2
34E	174.5	232.5	1047.0	1395.0	1221.5	1627.5	1396.0	1860.0

TABLE V-B—PROBABLE EXPECTANCY ON CUBIC YARD BASIS

	Pavers 27E	34E
Per Batch	1.053	1.333
Per Hour	30.62	58.15
7-Hour Shift	214.34	407.05
8-Hour Shift	244.96	465.20

Table V-A is used for checking purposes and as a guide for contractors in connection wtih their progress schedules. The quantities shown are the result of applying the average job efficiency rating from Table III of 72.7 per cent to the theoretical maximum hourly yardage of Table III-A.

In the first part of this article it was stated that while records indicate that between April 15th and June 22nd there have been an average of 43 paving days, this figure could not be accepted for this project. Table VI was

TABLE IV

Control No.	Trucks Hrs. Min.	%	Breakdowns Hrs. Min.	%	Forms Hrs. Min.	%	Fin. Gr. Hrs. Min.	%	Time Hrs. Min.	%	Misc. Hrs. Min.	%	Total Hrs. Min.	%
C	6–06	12.07	17–09	35.5	0–42	1.4	0–30	1	18–00	37.2	5–49	12	48–16	24.4
D	3–10	10	17–00	53							11–45	37	31–55	32.1
E	2–39	25.3	5–10	49.3							2–38	25.4	10–27	9.4
F	0–45	6.6	8–30	74.6							2–10	18.7	11–25	29/7
A	18–44	17.8	22–03	20.9	5–20	5.1	5–00	4.8	48–00	45.7	5–50	5.7	104–57	160.
Total	31–24	15.2	69–52	33.8	6–02	2.9	5–30	2.6	66–00	31.9	28–12	13.06	207–00	18.7

made to show the probable paving days for the spring of 1940.

TABLE VI—PROBABLE PAVING DAYS—1940

Data obtained from paving records over a period of years.

April—10 paving days
May —20 " "
June —24 " "

Further analysis shows that between April 1 and June 22, 48 paving days may be expected, and between April 15 and June 22, 44 paving days.

The probable paving days for all contracts during 1940, therefore, is 46. On this basis, an average of 87,000 sq. yds. must be placed each day. At the peak of the season with 28 paving contracts under way, an average of 3,100 sq. yds. must be placed daily on each contract. From these figures it can be determined that the daily operating time per contract for a 27E paver, must average 25½ hrs., and for a 34E paver, 13½ hrs. Operating time will vary, depending upon the size of the contract and the date that work gets under way. Tables VII and VIII show daily needed paving hours for different sized pavers and other equipment, for various sized contracts. These requirements are computed on the basis of the data shown in Table VA-Probable Outputs. Table VII is presented in two parts a 48 probable paving day schedule and a 44 probable paving day schedule. No interpolation may be applied to these tables; the contract quantity nearest the "Size of Contract—Square Yards" should be used to check against. Naturally, each job must be analyzed individually in determining job needs. The conditions applicable to each job will necessarily vary these deductions. However, for general planning of the whole project this analysis serves as a guide to equipment requirements.

TABLE VIII—ESTIMATED EQUIPMENT REQUIREMENTS

Approximate Total Yardage	4,360,000 Sq. Yds.
Placed during 1939	354,797 Sq. Yds.
To be placed—1940	4,005,203 Sq. Yds.

April 1 to June 22
48 Probable Paving Days

Size of Cont. Sq. Yds.	Lin. Ft. 12' Pave. Daily	Sq. Yds. Daily	Paving Hrs. Daily 27E	or 34E	Minimum Requirements Using 27E Pavers	Shifts	Using 34E Pavers	Shifts
75,000	1172	1563	13	7	1	2-7	1	1-7
100,000	1563	2084	17	9	1	2-8	1	1-8
125,000	1954	2605	20	12	1	3-7	1	2-7
150,000	2345	3126	25	14	2	2-7	1	2-7
175,000	2736	3647	30	16	2	2-8	1	2-8
200.000	3127	4167	34	18	2	2-8	1	2-8
225,000	3518	4688	38	20	2	3-7	1	3-7
250,000	3909	5210	43	22	3	2-7	2	2-7
275,000	4300	5731	47	24	3	2-8	2	2-7
300,000	4691	6252	51	27	4	2-7	2	2-7

April 15 to June 22
44 Probable Paving Days

Size of Cont. Sq. Yds.	Lin. Ft. 12' Pave. Daily	Sq. Yds. Daily	Paving Hrs. Daily 27E	or 34E	Minimum Requirements Using 27E Pavers	Shifts	Using 34E Pavers	Shifts
75,000	1279	1705	14	8	1	2-7	1	1-8
100,000	1705	2273	15	10	1	2-8	1	2-7
125,000	2131	2841	23	12	2	2-7	1	2-7
150,000	2557	3409	28	15	2	2-7	1	2-8
175.000	2983	3977	33	17	2	2-8	1	2-8
200,000	3409	4545	37	20	2	3-7	1	3-7
225,000	3835	5113	42	22	3	2-7	2	2-6
250,000	4261	5681	47	25	3	2-8	2	2-7
275,000	4687	6249	51	27	4	2-7	2	2-7
300,000	5113	6817	56	29	4	2-7	2	2-8

Table VIII is premised on the operation of a 27E and 34E paver working in tandem, the assumption being that all operations will be coordinated so as to avoid friction and confusion and to eliminate all delays due to possible interference with each other. The tabulation is based on probable outputs of 355 sq. yds. per hr. when two batch plants are used and 305 sq. yds. per hr. with only one batch plant. In the latter case the 34E would be functioning as a 27E due to the fact that the scales at the plant would have to be set to accommodate the smaller paver. Using two batching plants, the increase would amount to only 15 batches per hour.

TABLE VIII—TANDEM PAVER OPERATIONS—PROBABILITIES

Size of Contract Sq. Yds.	Paver Hrs. Required 1 Batcher	2 Batchers	Days Required 1 Batcher Shifts 2-8 Hr.	3-7 Hr.	2 Batchers Shifts 2-8 Hr.	3-7 Hr.
75,000	246	212	16	12	14	10
100,000	328	282	21	16	18	14
125,000	410	353	26	20	22	17
150,000	492	423	31	24	27	20
175,000	574	493	36	28	31	24
200,000	656	564	41	31	35	27
225,000	738	634	46	35	40	30
250,000	820	705	51	39	44	34
275,000	902	775	57	43	49	37
300,000	984	845	62	47	53	40

Fig. 3—Preparations Weeks Ahead of Paving Operations at Batching Plant and Stock Pile Site Required to Meet Schedule. Wm. D. Vogel Job on April 11, 1940.

To determine the number of combination units that will be required:—Estimate probable paving days (Table VI) in period involved. If less than "Days Required" in above table, using column applicable to particular contract—batchers and shifts— only one unit will be needed. If more, divide "Days Required" by probable paving days. Answer will be units necessary.

Batch Plant Setup on Andrews and Andrews Job at New Baltimore, Pa. All Set for 27E Batching. Note Extra Cement Bin.

PAVING PROCEDURE AND PERFORMANCE ANALYZED

Two Typical Methods of Equipment Organization and Construction Procedure Explained

By JOHN D. PAUL

Assistant Chief Construction Engineer, Pennsylvania Turnpike Commission

IN November, 1938, shortly after the organization of the engineering staff, it became necessary to schedule engineering design and construction of the Pennsylvania Turnpike. It then appeared that grading, drainage, and bridge construction operations during the following year should be completed in an unusually short period to make way for the paving. Paving presented quite a different problem since the project completion date was set for June 29th, 1940. It necessarily followed that a maximum paving mileage should be placed during the late fall or as early in 1939 as grading contracts could be completed and paving contracts started. Time allowances in grading contracts were limited to the extreme. Further provisions were needed to release portions of these contracts for early paving. In these grading contracts the paving problem was given careful consideration.

Paving Requirement Studies. — The beginning of several paving contracts late last Summer presented an opportunity to study problems of production, organization, materials, etc., since it was apparent at a very early date that new paving methods and organization must develop. Such studies, one of which is given in this issue as the article on "Planning Paver Equipment Requirements," were made and proved a valuable source for guidance in analyzing future contracts.

Construction Schedules and Material Supplies.— Materails supply investigations continued during the Winter months, the Construction and the Materials Division cooperating in order to determine adequacy of supply of all paving materials. Even though all of the paving contracts had not been awarded, there was not sufficient time to await the preparation of schedules by contractors particularly as to the sources of supply and the rail transportation facilities. As soon as contract awards were made, as shown by Table I, contractors were requested to supply very detailed information by means of a questionnaire as to the method they proposed to use in handling their work, material sources, location of unloading plants, etc. Early compilation of the data as to materials required confirmed the early analysis and indicated that large stock piles would be required in all cases to carry over the peak period of construction. At first glance, it appeared that the peak would occur in the latter part of May and the early part of June. Each paving contractor was interviewed and acquainted with the facts that had been established not only as to the requirements for materials, but as to arrangements they had made for equipment, organization, and plans for performing the work. Attempts were made to obtain a maximum amount of stocked materials by April 1, but general unsatisfactory weather conditions prevented the attainment of the goal at that time. With the advance of Spring weather stock increased rapidly and as of May 15 there was on the whole a greater amount of materials stored than was stock piled at the beginning of the paving season, late in April, notwithstanding the volume of paving that has been laid. Needless to say, it is expected now that there will be no material shortages.

Truck Hauling.—It was anticipated that the volume of paving necessary would involve a large number of batch trucks and bulk hauling trucks and aside from the possibility of a truck shortage the damaging action of such hauling on public roads in the early spring could be visualized. In certain cases gross load restrictions were placed on roads by the Department of Highways, which under the law they are permitted to do. The contractors thus far have readily adapted their hauling to these conditions, since they have had an advance warning in all cases by means of earlier conferences with them. Contractors have been most cooperative and it is believed that conservative, workable schedules presented by them will exceed in equipment requirements, the predicted expected requirements shown in Mr. Stone's article in this issue.

Personnel Studies.—Coincident with the analysis of schedules, engineering personnel requirements were carefully examined, budgets established and preparations made for training new men thus required although many engineering assistants qualified for paving work had been employed for almost a year on the grading and drainage contracts.

Grading Contracts.—The curves in Fig. 1 show the scheduled and the actual construction yardage for grading as of May 1, 1940.

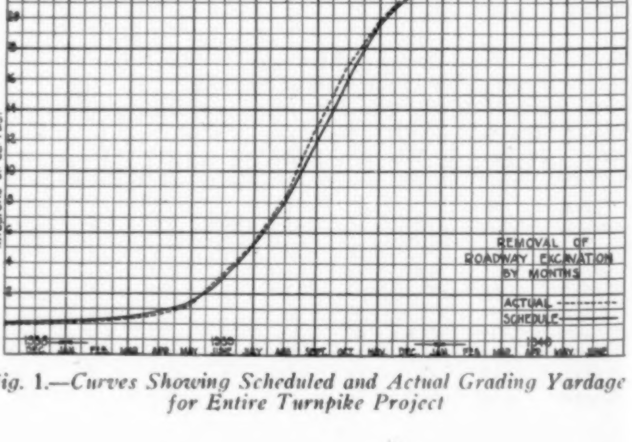


Fig. 1.—Curves Showing Scheduled and Actual Grading Yardage for Entire Turnpike Project

TABLE I.—LIST OF CONTRACTS AS AWARDED BY THE PENNSYLVANIA TURNPIKE COMMISSION
(Continuation of Table I, pg. 79, Oct., 1939, ROADS AND STREETS)

Contract No.	Section	Name of Contractor and Address	Date Awarded	Amount of Contract	Type of Construction	Calendar Days	Length Feet	Total* Paving Mi. to Date
30	S4	Capitol Const. Co. Hollidaysburg, Pa.	11-10-39	$144,163	Ventilation Buildings E. & W. Sideling Hill Tunnel	218		
31	L4	Navarro Corporation Pitstburgh, Pa.	11-10-39	$188,954	Ventilation Buildings E. & W. Laurel Hill Tunnel	218		
52	T4	Boyd H. Kline Bloomsburg, Pa.	12-18-39	$148,797	Ventilation Buildings E. & W. Tuscarora Tunnel	175		
53	K4 B4	R. S. Noonan York, Pa.	12-5-39	$269,859	Ventilation Buildings E. & W. Kittatinny Tunnel W. Blue Mt. Tunnel	191		
54	4H	John Hall Ligonier, Pa.	12-18-39	$44,797	Heating Systems and Mechanical Installations	175		
55	4P	Pitt Constr. Co. Pittsburgh, Pa.	12-18-39	$109,850	Plumbing Systems	175		
62	4P1	Mid-West Con. & Asphalt Co. Chicago, Ill.	11-10-39	$583,430	R. C. Pavement and Incidental Work	By 6-22-40	30,946	80.69
63	5P1 6P1	Tri-State Engineering Co. Washington, Pa.	11-10-39	$616,620	R. C. Pavement—Structure Incidental Work	By 6-22-40	31,197	86.60
64	A-4	Ritter Bros. Harrisburg, Pa.	12-18-39	$158,410	Ventilation Buildings E. & W. Allegheny Tunnel	175	XXX	XXX
65		Johns Manville Corp. Philadelphia, Pa.	12-5-39	$2,902	1060 Tunnel Ceiling Light Boxes	50	XXX	XXX
66	14P1	States Engineering Co. Rapids City, S. D.	12-5-39	$319,574	R. C. Pavement— Incidental Work	By 6-22-40	17,054	89.83
67	18P1 19P1	States Engineering Co. Rapids City, S. D.	12-5-39	$508,919	R. C. Pavement— Incidental Work	By 6-22-40	26,294	94.81
68	2P2	Baldwin Bros., Paving Co. Cleveland, Ohio	12-18-39	$442,644	R. C. Pavement— Incidental Work	By 6-22-40	22,458	99.06
69	12P2 13P1	W. L. Johnson Constr. Co. Hicksville, Ohio	12-18-39	$287,414	R. C. Pavement— Incidental Work	By 6-22-40	15,969	102.08
70	8P2	Union Paving Company Philadelphia, ,Pa.	12-18-39	$307,600	R. C. Pavement— Incidental Work	By 6-22-40	14.511	104.83
71	18P2	Union Constr. Co. Des Moines, Iowa	12-18-39	$978,299	R. C. Pavement— Incidental Work	By 6-22-40	54,014	115.06
72	5P2	William O'Neil Sons' Co. Faribault, Minn.	1-12-40	$412,249	R. C. Pavement— Incidental Work	By 6-22-40	22,708	119.36
73	13P2	Walker Bros. Chambersburg, Pa.	1-12-40	$292,839	R. C. Pavement— Incidental Work	By 6-22-40	15,770	122.35
74	3P2 4P2	Adam Eidemiller Greensburg, Pa.	1-12-40	$615,043	R. C. Pavement— Incidental Work	By 6-22-40	36,108	129.19
75	12P3 12P4	McNally & Hobeck Saginaw, Mich.	1-24-40	$594,913	R. C. Pavement— Incidental Work	By 6-22-40	32,578	135.36
76	R-4	J. F. Drass Hollidaysburg, Pa.	1-12-40	$120,932	Ventilation Building and Portal Structure	156		
77	5P3	Frank Mashuda Milwaukee, Wis.	1-12-40	$378,336	R. C. Pavement and Structures	By 6-22-40	5,600	136.42
78	TO-1	Moyer Bros. Altoona, Pa.	2-9-40	$138,974	Ticket Offices	By 6-22-40		
79	TH-1	Snively Bros. Pittsburgh, Pa.	2-9-40	$9,150	Heating Systems for Ticket Offices	By 6-22-40		
80	TP-1	John L. Thomas York, Pa.	2-9-40	$15,290	Plumbing Systems for Ticket Offices	By 6-22-40		
81	TE-1	W. V. Pangborn Philadelphia, Pa.	2-9-40	$53,500	Electrical Systems for Ticket Offices	By 6-22-40		
82	13P4	Harrison Constr. Co. Pittsburgh, Pa.	2-9-40	$326,303	R. C. Pavement Incidental Work	By 6-22-40	17,281	140.14
83	14P2	W. L. Johnson Constr. Co. Hicksville, Ohio	2-29-40	$340,427	R. C. Pavement Incidental Work	By 6-22-40	15,153	143.01
84	9P2 10P1 11P2	Andrews and Andrews, Inc. New York City, N. Y.	2-29-40	$738,579	R. C. Pavement Incidental Work	By 6-22-40	39,283	150.45
85	4-E	Day and Zimmerman, Inc. Philadelphia, Pa.	3-20-40	$439,200	Electric Light and Power Systems	By 6-29-40		
86	GF	Joseph D. Bonness, Inc. Milwaukee, Wis.	4-9-40	$517,781	Guard Fence 557,000 ft.	70		
87		Lighthouse Service Co. Pittsburgh, Pa.	3-13-40	$30,812	900 Traffic Signs	By 6-22-40		
88	13P3	Walker Bros. Chambersburg, Pa.	3-13-40	$309,072	R. C. Pavement and Structures	By 6-22-40	15,153	153.32
89	F5	Michael Flynn Mfg. Co. Philadelphia, Pa.	4-2-40	$29,430	Niche and Manhole Covers	70		
90	PR1 PR2	Harrison Constr. Co. Pittsburgh, Pa.	4-9-40	$94,953	Restoration of Surfaces on State Highways	70		

TABLE I—*Continued*

92	PR3 PR4	Harrison Constr. Co. Pittsburgh, Pa.	4-16-40	$145,362	Restoration of State Highway Surfaces	70	
93	4LU	Westinghouse El. & Mfg. Co. Philadelphia, Pa.	4-30-40	$16,960	1060 Tunnel Ceiling Luminaries	53	
94	RWF	Pittsburgh Steel Co. Pittsburgh, Pa.	5-14-40	$328,476	Fencing Type No. 1, 17,220 ft. Type No. 2, 134,444 ft. Type No. 3, 324,326 ft. Type No. 4, 185,000 ft.	65	
95	MB-1	John Stapf Harrisburg, Pa.	5-21-40	$62,218	Five Maintenance Buildings		
96	4LT	Westinghouse Elec. Sup. Co. Philadelphia, Pa.	5-14-40	$38,111	1104 Mercury Lamps, Type AH-5	40	1075 Mercury Lamps Transformers
97	4MH	Wm. M. Clark Co. New Castle, Pa.	5-21-40	$5,515	Heating Systems for Five Maint. Buildings	75	
98	4MP	Wm. M. Clark Co. New Castle, Pa.	5-21-40	$5,060	Plumbing Systems for Five Maintenance Buildings	75	
99	4ME	Brownsville Con. Co. Brownsville, Pa. J. D. Finn Hollidaysburg, Pa.	5-21-40 5-21-40	$1,782 $1,710	Electric Systems for Five Maintenance Buildings	75	
100	4PW	To Be Awarded			At 8 Ticket Offices 5 Main. Bldgs. and 13 Portal Bldgs.	70	

NOTE.—Feet and miles of construction pertains only to turnpike distances and not distances for side-road construction which is included in amount of contract.

* Four Lane Pavement. Does not include 6.7 miles of two lane pavement in tunnels.

Grading and drainage contracts were not all completed and steps were taken to coordinate completion of these contracts with the beginning of paving contracts to avoid the minimum of complications and the maximum of efficiency in operation and production. This coordination required careful study as it involved the intermediate step of final engineering arrangements on grading and drainage contracts and the staking of the succeeding paving contract. Overlapping contracts were not uncommon.

Tunnel and Miscellaneous Contracts.—The work and efforts of tunnel contractors and those performing miscellaneous work, such as guard fence, electrical, buildings, signs, etc., are closely tied into and co-ordinated with the paving operations in order that no delays or interference will be experienced by either.

Paving Production. — The paving graph, Fig. 2, represents the summation of all paving contracts showing scheduled progress and actual progress to May 15. It is of interest to note that although the schedule for the present was begun on April 1, production did not attain any degree of speed until April 15. This can be accounted for by the anticipated weather conditions previously mentioned, varying for the different sections of the Turnpike. Actually, all weather conditions during the past winter and certainly throughout April were below average. Extremely unsatisfactory conditions have been noted in many cases where normally favorable weather could be expected. Generally, contractors have scheduled and have been working two shifts of 6, 7 or 8 hours. A few have employed 3 shifts, usually 7 hours each and it is expected that others may utilize 3 shifts very soon. Further explanation showing the estimated and actual paving days to May 15 is shown separately in Table II, entitled, "Summary of Paving Delays." It might be well to note here that after May 1 the direction taken by the actual production curve is approximately the same as the direction taken by the schedule line. The variation in direction is explainable in part by the actual paver delays as shown. Further reference to this tabulation of delays will show that early prediction of truck delays are, in a measure, borne out although it was not anticipated that the lost time due to breakdowns would

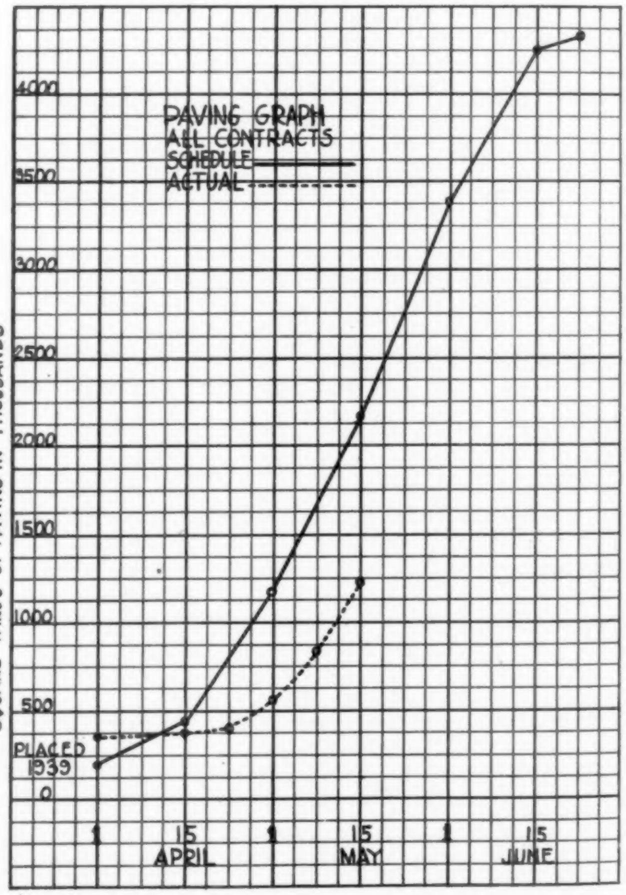


Fig. 2.—Curves Showing Scheduled Paving Yardage and Actual Yardage Placed

be quite as extensive since the major portion of the equipment in use is new. Miscellaneous delays normally termed minor delays appear to be out of proportion to the others as well as time lost due to forms. Quite a large portion of all of these delays is, undoubtedly, attributable to the breaking-in period at the start of the contracts.

TABLE II—SUMMARY OF PAVER DELAYS

Estimated Paving Days Schedule	*Actual Paving Days*	*Trucks*	*Breakdowns*	*Forms*	*Fin. Gr.*	*Labor*	*Misc.*	*Total*
				April 1 to April 30				
141	93	50½	90½	47½	13½		65½	267½
				May 1 to May 15				
256	241	176	143½	73½	39	28	114	574
397	334	226½	234	121	52½	28	179½	841½

Time shown to nearest one-half hour.
Average efficiency for April—63%.
Average efficiency to May 15—67%.
Time lost—adverse weather conditions—April 34%—May 6%.
Trucks—Delays created through insufficient trucks; slowness in loading or unloading, and poor handling.
Breakdowns—Occurring at paving operation, plant and pumps.
Forms—Necessary to rebuild or re-align.
Fine Grade—Insufficient grade ahead of paver, or grade not satisfactory.
Labor—Progress impeded by no labor or lack of skilled labor.
Miscellaneous—Lack of water, cement or other material; slowness in finishing, slowness at batch plant, etc.

The continuance of the delays throughout the early part of May is understandable to a certain degree because not all of the paving contracts could begin work in April principally because of the bad weather. It is yet too early to predict the loss that might be experienced during the latter part of May but with every effort being made not only by the engineers and inspectors but by the contractors themselves to step up production, considerable improvement is anticipated.

Paving Equipment

There are 29 paving contracts, one of which is completed. Two short contracts have not started at present but will be constructed in connection with other contracts nearby. Two contracts are being paved in 24-foot width; the remaining 26 in single lane widths of 12 feet each. A tabulation of equipment on all active paving contracts is shown in Table III.

It will be noted that a number of combinations have been arranged in the use of pavers. For example, there are seven operations in which 34E and 27E mixers are in tandem, eleven single 34E's one dual 27E, one single 27E, two tandem operation involving dual 27E and single 27E, and two where 27E's operate in tandem. A number of changes in these operations have been made since the contracts were started and where greater production was needed additional mixers were added. It is entirely likely that addional paving equipment will be needed depending entirely upon the production that is obtained with the units now in use. It is noted that mechanical spreaders of two types are in common use with two transverse finishing machines followed by a longitudinal or bull float.

Typical Paving Contracts

(a)—34E Paver

A typical operation, involving the use of a single 34E paver, begins at a batch plant usually located as close to the work as siding facilities can be obtained. This varies up to about nine miles in the extreme case, the average is much shorter; many of them are on the work itself. Railroad facilities are not usually coincident with the job and so supplemental bulk hauling must be undertaken, and in a number of cases is handled either through trestle or by supplemental cranes at the siding. The contractor usually uses from ten to thirty trucks depending upon the length of the haul. Trucks, in this typical case, are two-batch capacity. Since, in this case, stock piles are located immediately adjacent to the railroad tracks one crane is generally used to unload and two cranes to supply the bins from the stock piles. It must be remembered that specifications require the use

TABLE III—EQUIPMENT AND OPERATING METHODS ON PAVING CONTRACTS

Contract No.	*Shifts No.*	*Shifts Hrs.*	*Pavers 27E*	*Pavers 34E*	*Operating Method*	*Spreaders*	*Batchers*	*Finishers Trans.*	*Finishers Long*	*Sq. Yds. Placed to 5/22/40*
68	2	7		1 Koehring	12′ width	1	2	1	1	33,975
60	2	7	1 dual—Ransome and 1 Rex		24′ width—Tandem—2 courses	1	1	1	1	25,435
74	2	7	1 Koehring	1 Koehring	12′ width—Tandem—2 courses	1	1	2	1	45,197
62	2	7	1 Foote	1 Koehring	12′ width—Tandem—2 courses	1	1	2	....	66,036
72 & 77	2	7	1 Rex	1 Rex	12′ width—2 courses—27E batches	1	1	1	1	17,349
63	2	7	1 Koehring	1 Koehring	12′ width—Tandem—27E batches	1	1	1	1	44,607
49	2	7		1 Rex	12′ width	1	1	2	....	123,701
56 & 70	2	8	1 Ransome	1 Koehring	12′ width—Tandem—27E batches	1	2	2	1	72,767
50	2	8	2 Ransome		12′ width—Tandem	1	1	2	....	54,170
84	2	7	1 dual—Ransome and 1 Koehring		12′ width—Tandem—2 courses	1	1	2	1	12,578
66			1 dual—Ransome		12′ width	1	1	1	1	4,506
57	2	7	1 Rex & 1 Ransome	1 Rex	12′ width—2 courses—Tandem	1	2	2	1	68,992
75	2	7	1 Rex	1 Koehring	12′ width—2 courses—Tandem	1	2	2	1	50,012
69	2	7	1 Koehring	1 Koehring	12′ width—Tandem—27E batches	1	1	3	1	48,931
73 & 88				1 Rex	12′ width	1	1-dual	2	1	68,403
59	2	8		1 Koehring	12′ width	1	1	2	1	61,757
51	3	7		1 Koehring	24′ width	1	1	1	1	154,288
61	2	7	1 Rex		12′ width	1	1	1	....	30,422
58	2	8		1 Rex	12′ width	1	1	2	1	78,383
71	2	8	2 Rex Operating as separate outfits	1 Rex	2 12′ widths, inside one side, outside other side	4	2	4	4	64,622
67	2	7		1 Koehring	12′ width	1	1	1	1	43,589
46	2	7		1 Koehring	12′ width	1	1	1	1	62,767
47	2	8		1 Koehring	12′ width	1	1	1	1	100,807
82	2	8	2 Koehring		12′ width—2 courses	1	1	2	1	To start 5/27
83	2	8	1 Koehring	1 Koehring	12′ width—2 courses	1	1	1	....	5/27

of two stone sizes and that sand be stock-piled for twelve hours. Two bins, equipped with weighing devices, are used to supply the paver. The cement bin is approximately 150-barrel capacity and the three-compartment aggregate bin is approximately 105-ton capacity. In good weather, when paver production is high, cranes must frequently interchange operations in order to keep materials moving and quite often it is necessary to provide three shifts for unloading materials. Material proportioning is closely controlled by the inspectors on the bins. Additional control is afforded by tests for aggregate grading, material moisture content, etc., improvised by a materials inspector under the direction of a District Concrete Engineer.

The strength of any paving operation, like a chain, is but as strong as its weakest part, and so the contractors usually provide motor graders to trim and reshape the grade, closely followed by form-grading machine and form-setters who save considerable time in their operations by the use of a pneumatic hammer in driving the pins. A certain amount of scarifying is necessary between the forms followed by the operations of a subgrade machine. A final adjustment of the forms makes them ready for the pavement. Subgrade testers are freely used and corrections made to the subgrade and forms where required. Prefabricated expansion joint assemblies are installed together with removable longitudinal joint plates and bent transverse tie bars. Paver operation closely follows outside the forms, placing concrete which is checked for water content during the day

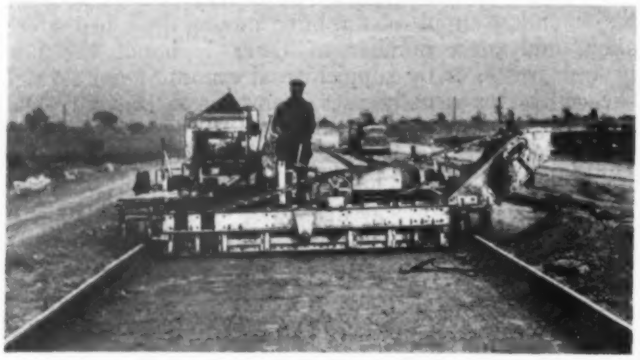


Fig. 3.—Subgrader on John H. Swanger Job Prepares the Fine Grade to Proper Cross-section. On Two Jobs 24 ft. Machines Are Working, the Rest are 12 ft. Units

from information sent to the mixing inspector from the batch plant inspector. The concrete engineer coordinates and controls the activity of these two men with respect to the quantity of concrete materials being supplied and amount of mixing water to be added in relation to resulting workability, the maximum being 5½ gallons per bag of cement. During the day inspector frequently makes slump determinations in the usual manner, which are duly recorded and related to the amount of mixing water added. Form settlement tests are regularly made. The mechanical spreader levels off the first course paving after which the steel reinforcing mats are placed in a position two inches below the surface of finished pavement. Following the placement of the concrete on top of the reinforcement the spreader again operates and transverse finishing machines follow closely. It is very necessary that all three of these spreading and finishing machines be carefully regulated both as to position of screeds above the forms as well as relation to each other and to the mixer itself in consideration of the speed of the paver. Any laxity on the part of any of the operators or failure of the equipment itself almost surely means a shut-down or delay. After bleeding of the concrete is noted a longitudinal float begins its operation and in this case it is particularly important that all laitence be swept clean of the pavement and not permitted to return with the succeeding pass of the screed. Straight edge operators follow closely, working from both edges of the pavement and drag-belting the surface follows in the usual way. Preliminary opening of the joints and edges follows this step. The placing of double layers of saturated burlap on the surface is the next step. Pavement is cured by the use of this burlap saturated for a period of 24 hours following which the contractor may, at his discretion, use any one of several methods for the remaining 48-hour period. Practically all at present are using a curing cover of Sisalkraft paper. Water is supplied the mixer as for curing by tank trucks equipped with special hose and sprinkler attachments.

Forms are removed and the burlap mats moved ahead at the end of the 24-hour period. The paper is laid after the pavement has been thoroughly sprinkled with water. The edges of the pavement are banked to seal the paper covers which remain until the expiration of the total curing period of 72 hours. After the removal of the paper the edges of the pavement are again banked, the banking on the interior edge of course being removed just prior to paving the pavement on the adjacent lane. The operation as a whole is much like the normal paving condition except that operations extend over a greater length and must be vary carefully coordinated to avoid delays in one or more functions of the paving crew. This whole operation requires skillful management to increase overall efficiency.

Fig. 4.—Paving Operations on Bloomer Construction Co. Job. The 34E Double Drum Paver Is Placing a 24 ft. Width. On Many Jobs Pavers Work In Tandem

Tandem Operation

(a)—34E and 27E Pavers

Of the several tandem operations, the combination of the 27E and 34E paver is used to the greatest extent, the 34E placing the base course and the 27E the top. In one case, which can be considered typical, the general operation is practically the same as that described for the 34E paver except that it involves some different considerations because of the variance of the sizes of the batches. In this typical case all materials are received at the railroad siding about six miles from the job, siding capacity being ten cars of cement, 30 cars of sand and 50 cars of stone. It is elevated so that materials in hopper bottom cars can be dumped directly into trucks which haul from that point to the batch plant on the site of the work. Stone and cement are dumped directly into the bins which have been located at the base of a 25-foot cut. Sand is dumped on the stock pile to fulfill the storage requirement of 12 hours. After this time has expired the sand is rehandled with a bucket loader into trucks and dumped directly into the bin. The aggregate

bin is of approximately 115-ton capacity, providing for sand and two sizes of stone. Six beam scales at each discharging hopper permits two batches to be dumped at the same time without movement of the truck. Loading averages about 27 to 34 trucks an hour. The maximum output has been 90 batches and it is possible that a greater number can be obtained under pressure. The cement bin is approximately 270 bbls. capacity. The location of the batch bins is such that straight line operation of trucks is possible. Approximately 6 cement trucks, 4 sand trucks, and 30 stone trucks are necessary to keep the batch plant in operation. For emergency or peak operation a 1½ yd. crane is available at the batch plant.

Mixer production and concrete handling is controlled largely by the proper distribution of trucks to the two mixers and also by maintaining the mixers at a constant distance from each other. Thus far it has proven

Fig. 5.—New Type Concrete Spreader in Which Rotating Paddles, Like the Rotor of a Domestic Tub Washing Machine, Spreads Concrete Just Dumped From the Mixer

most satisfactory if a distance between them does not exceed about 75 ft. Production and operation of 27E single and dual mixers are generally known but are used in very few cases on this work. Other combinations of single and dual 27E's are infrequently noted with varying degrees of success.

It is expected that better results from mixer combinations, whether in tandem or otherwise, will develop greater progress in the very near future. For the most part the contractors are paving the inside lanes first. There are a few exceptions where outside lanes are paved first in order to enable the contractor to proceed with shoulder operations while his paving is being com-

Fig. 6.—Final Curing on Practically All Jobs Is Done With Sisalkraft Paper

pleted, this occasioned by very limited contract time. In one case a single 34E is paving an inside and an outside lane on opposite sides of the road at the same time, paver operating between the lanes.

Each step in the paving operation is very carefully checked by our inspectors and engineers in relation to the contract requirements, corrections being applied when and as required. Quality is not sacrificed for speed in production. Contractors and engineers alike are striving to produce both to the degree expected.

Continuous observations are made on the operation of the paver with particular reference paid to the amount of time lost in various controlling operations and the production that the contractor could have obtained compared with what was actually accomplished, resulting in a certain degree of efficiency. This means of control was adopted after observation last Fall had indicated it to be a valuable asset not only to ourselves but to the contractor as well. It also enables progress to

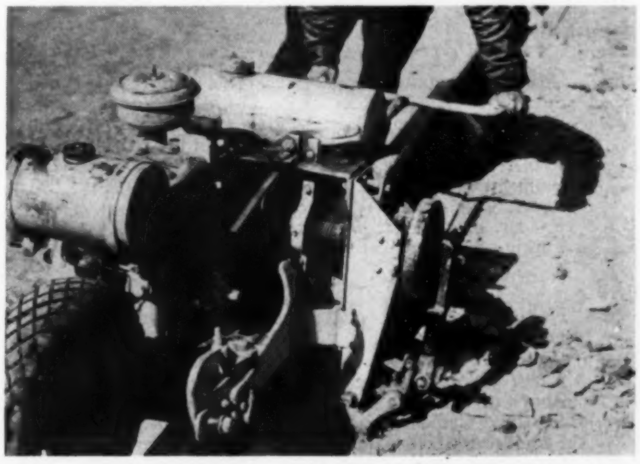


Fig. 7.—Form Tamping Machines Insure a Solid Footing to Carry the Forms Over Which Subgrader, Concrete Spreader, and Finishing Machines Must Operate

be very carefully charted from day to day, with full realization of the necessity for taking advantage of every favorable opportunity for paving in view of the completion date established for the work and within the time set in a specific contract.

It is of interest to note the relative efficiency of the various operations and their relation to the expected average efficiency of approximately 73 per cent which is now closely approximated. Indications point to a steady increase in the average, the extent of which cannot be predicted now.

TABLE IV—QUANTITIES AND UNIT PRICES BID
(A continuation of Table III, pg. 87, October, 1939, Issue of ROADS AND STREETS*)*

Contract No.	Description	Quantities	Unit Price Bid
30	Excavation	520 cu. yds.	$ 4.00
	Derrick and Hand Placed Stone Fill	110 cu. yds.	15.00
	Earth and Stone Fill	9,000 cu. yds.	.50
	Concrete Masonry	2.600 cu. yds.	16.00
	Structural Steel—Class A	47,000 lbs.	.08
	Structural Steel—Class B	112,000 lbs.	.15
	Reinforcing Rods and Wire Mesh	353,000 lbs.	.045
31	Excavation	2,800 cu. yds.	$ 3.00
	Earth and Stone Fill	14,700 cu. yds.	1.50
	Concrete Masonry	2,720 cu. yds.	25.00
	Structural Steel—Class A	47,000 lbs.	.06
	Structural Steel—Class B	97,000 lbs.	.13
	Reinforcing Rods and Wire Mesh	375,000 lbs.	.05

TABLE IV—*Continued*

Grading and drainage items listed in October issue, 1939

Contract No.	Description	Quantities	Unit Price Bid
49	Roadway shaping	40,535 lin. ft.	$ .10
	Subgrade	221,941 sq. yds.	.08
	Shoulders	40,867 lin. ft.	.15
	Reinf. Cem. Conc. Pavement 9" uni. in dep.	220,491 sq. yds.	2.61

Grading and drainage items listed in October issue, 1939

Contract No.	Description	Quantities	Unit Price Bid
50	Roadway shaping	42,690 lin.ft.	$ .09
	Subgrade	228,123 sq. yds.	.10
	Shoulders	42,080 lin. ft.	.20
	Reinf. Conc. Pavement 9" uni. in dep.	226,673 sq. yds.	2.78
	Reinf. Cem. Conc. Wear. Surf,-Br. Floors	1,348 sq. yds.	1.80

Grading and drainage items listed in October, 1939, issue

Contract No.	Description	Quantities	Unit Price Bid
51	Roadway Shaping	34,696 lin. ft.	$ .10
	Subgrade	214,747 sq. yds.	.09
	Subgrade Material	175 cu. yds.	1.00
	Shoulders	38,481 lin. ft.	.15
	Reinf. Cem. Conc. Pavem. 9" uni. in dep.	212,907 sq. yds.	2.92
	Reinf. Cem. Conc. Wear, Surf. —Br. Floors	402 sq. yds.	3.00
	Foreign Borrow Excavation	10,345 cu. yds.	.50

Contract No.	Description	Quantities	Unit Price Bid
52	Excavation	350 cu.yds.	$ 4.00
	Derrick and Hand Placed Stone Fill	100 cu. yds.	3.00
	Earth and stone fill	7,800 cu. yds.	1.25
	Concrete Masonry	2,550 cu. yds.	17.00
	Portland Cement	4,100 bbls.	2.88
	Structural Steel—Class A	48,000 lbs.	.062
	Structural Steel—Class B	102,000 lbs.	.154
	Reinforcing Rods and Wire Mesh	346,000 lbs.	.045

Contract No.	Description	Quantities	Unit Price Bid
53	Excavation	1,100 cu. yds.	$ 4.23
	Derrick and Hand Placed Stone Fill	100 cu. yds.	3.03
	Earth and Stone Fill	18,300 cu. yds.	.935
	Concrete Masonry	4,800 cu. yds.	20.35
	Portland Cement	7,700 bbls.	2.88
	Subbase Material	230 cu. yds.	4.84
	Subgrade Material	50 cu. yds.	4.84
	Structural Steel—Class A	95,500 lbs.	.066
	Structural Steel—Class B	195,000 lb.	.145
	Reinf. Rods and Mesh	674,000 lb.	.047
	Paved Drainage Ditch	530 sq. yds.	2.717

Grading and drainage items listed in October, 1939, issue

Contract No.	Description	Quantities	Unit Price Bid
56	Roadway shaping	14,840 lin. ft.	$ .10
	Subgrade	85,547 sq. yds.	.10
	Shoulders	16,040 lin. ft.	.12
	Reinf. Concr. Pavem. 9" unif.	85,547 sq. ft.	2.70
	Reinf. Concr. Wear Surf.	184 sq. yds.	2.00
	Segmental Grouted Rubble Spillway	41 cu. yds.	15.00

Grading and drainage items listed in October, 1939, issue

Contract No.	Description	Quantities	Unit Price Bid
57	Roadway Shaping	47,022 lin. ft.	$ .08
	Subgrade	267,846 sq. yds.	.08
	Shoulders	50,222 lin. ft.	.20
	Reinf. Cem. Conc. Pavem. 9" unif. in depth	267,846 sq. yds.	2.70
	Reinf. Cem. Conc. Wear, Surf Br. Floors	2,623 sq. yds.	2.50
	Segmental Grouted Rubble Spillway	30 cu. yds.	30.00

Grading and drainage items listed in October, 1939, issue

Contract No.	Description	Quantities	Unit Price Bid
58	Roadway Shaping	18,006 lin. ft.	$ .10
	Subgrade	96,866 sq. yds.	.10
	Subgrade Material	295 cu. yds.	1.00
	Shoulders	17,307 lin. ft.	.15
	Reinf. Cem. Conc. Pavem. 9" unif. in depth	95,286 sq. yds.	2.95
	Reinf. Cem. Conc. Wr. Surf. Bridge Floors	711 sq. yds.	2.50
	Segmental Grouted Rubble Spillway	50 cu. yds.	20.00

Grading and drainage items listed in October, 1939, issue

Contract No.	Description	Quantities	Unit Price Bid
59	Roadway Shaping	17,131 lin. ft.	$ .10
	Subgrade	109,388 sq. yds.	.08
	Subgrade Material	930 cu. yds.	.60
	Shoulders	18,832 lin. ft.	.20
	Reinf. Cem. Concr. Pavem. 9" unif. in depth	106,143 sq. yds.	2.96
	Reinf. Cem. Concr. Wr. Surf. for Bridge Floors	160 sq. yds.	2.50
	Segmental Grouted Rubble Spillway	20 cu. yds.	20.00
	Type W Inlets	2 each	100.00

Grading and drainage items listed in October, 1939, issue

Contract No.	Description	Quantities	Unit Price Bid
60	Roadway Shaping	26,895 lin. ft.	$ .08
	Subgrade	136,363 sq. yds.	.09
	Shoulders	26,895 lin. ft.	.15
	Reinf. Conc. Pavem. 9" depth	123,677 sq. yds.	2.66
	Reinf. Conc. Pavem. wear. Surf.-Bridge Floors	1,123 sq. yds.	2.50
	Reinf. Cem. Conc. Pav. 9" unif. depth. Var. Width	3,000 sq. yds.	2.80
	Manhole Structures	7 vert. ft.	20.00
	Inlet Structures	10 vert. ft.	20.00
	Segmental Grouted Rubble Spillway	65 cu. yds.	20.00

Grading and drainage items listed in October, 1939, issue

Contract No.	Description	Quantities	Unit Price Bid
61	Roadway Shaping	13,941 lin. ft.	.10
	Subgrade	71,168 sq. yds.	.10
	Shoulders	13,941 lin. ft.	.20
	Reinf. Cem. Conc. Pavem. 9" unif.	59,742 sq. yds.	2.91
	Reinf. Cem. Conc. Pavem. 9" unif. depth. Var. Width	4,970 sq. yds.	3.10
	Reinf. Cem. Conc. Wear. Surf. Bridge Floors	270 sq. yds.	3.00
	Segmental Grouted Rubble Spillway	33 cu. yds.	20.00

Contract No.	Description	Quantities	Unit Price Bid
62	Excavation Class 1	75 cu. yds.	$ 1.50
	Excavation Class 2	203 cu. yds.	3.00
	Roadway Shaping	30,906 lin. ft.	.11
	Subgrade	164,832 sq. yds.	.08
	Shoulders	30,906 lin. ft.	.18
	Reinf. Cem. Conc. Pavement, 9" Unif. in Depth	144,894 sq. yds.	2.87
	Special Reinf. Cem. Conc. Pavem. 9" Unif. in Depth	19,938 sq. yds.	3.45
	Class B Concrete	5 cu. yds.	35.00

Contract No.	Description	Quantities	Unit Price Bid
63	Excavation—Class 1	250 cu. yds.	$ .75
	Excavation—Class 2	513 cu. yds.	2.00
	Roadway Shaping	31,179 lin. ft.	.10
	Subgrade	167,368 sq. yds.	.10
	Shoulders	30,340 lin. ft.	.20
	Reinf. Cem. Conc. Pavem. 9" Unif. in depth	156,928 sq. yds.	2.90
	Spec. Reinf. Cem. Conc. Pavem. 9" Unif. depth	8,240 sq. yds.	3.15
	Class A Concrete	438 cu. yds.	30.00
	Class B Concrete	461 cu. yds.	22.00
	Plain Steel Bars	110,600 lb.	.05

Contract No.	Description	Quantities	Unit Price Bid
64	Excavation	250 cu. yds.	$ 4.30
	Derrick and handplaced stone fill	100 cu. yds.	2.86
	Earth and Stone Fill	9.000 cu. yds.	1.30
	Concrete Masonry	2,800 cu. yds.	17.90
	Portland Cement	4,500 bbls.	3.60
	Subbase Material	90 cu. yds.	3.30
	Subgrade Material	30 cu. yds.	3.60
	Structural Steel—Class A	48,000 lb.	.08
	Structural Steel—Class B	102,000 lb.	.172
	Reinf. Rods and Wire Mesh	380,000 lb.	.0554

TABLE IV—*Continued*

Contract No.	Description	Quantities	Unit Price Bid
65	Type A Ceiling Lights Boxes	965 each	$ 2.45
	B Ceiling Lights Boxes	67 each	4.42
	C Ceiling Lights Boxes	28 each	8.64
66	Class 1 Excavation	1,216 cu. yds.	$ .75
	Class 2 Excavation	237 cu. yds.	3.00
	Subgrade	90,675 sq. yds.	.10
	Shoulders	17,002 lin. ft.	.17
	Reinf. Cem. Conc. Pavem. 9" unif. in depth	77,875 sq. yds.	3.05
	Reinf. Cem. Conc. Wear. Surf. Bridge Floors	226 sq. yds.	3.35
	Top Soil Borrow	1,914 cu. yds.	.55
	Foreign Borrow Excavation	4,261 cu. yds.	.50
67	Class 1 Excavation	1,374 cu. yds.	$ .55
	Class 2 Excavation	1,021 cu. yds.	1.75
	Borrow Excavation	8,190 cu. yds.	.45
	Subgrade	157,827 sq. yds.	.09
	Reinf. Cem. Conc. Pavem. 9" unif. in depth	126,837 sq. yds.	2.62
	Reinf. Cem. Conc. Wear. Surf. Bridge Floors	470 sq. yds.	3.10
68	Class 1 Excavation	5,708 cu. yds.	$ .70
	Class 2 Excavation	90 cu. yds.	3.00
	Borrow Excavation	151 cu. yds.	.70
	Subgrade	132,580 sq. yds.	.15
	Shoulders	26,187 lin. ft.	.15
	Reinf. Cem. Conc. Pavem. 9" unif. in depth	100,084 sq. yds.	2.70
	Reinf. Cem. Conc. Wear Surf. Bridge Floors	2,038 sq. yds.	2.25
69	Class 1 Excavation	286 cu. yds.	$ .80
	Class 2 Excavation	182 cu. yds.	2.50
	Subgrade	78,704 sq. yds.	.10
	Shoulders	14,757 lin. ft.	.10
	Reinf. Cem. Conc. Pavem. 9" unif. depth	56,859 sq. yds.	2.84
	Reinf. Cem. Con. Wear Surf. Bridge Floors	6,581 sq. yds.	1.75
	Top Soil Borrow	1,160 cu. yds.	.60
	Approved Shale Borrow	3,689 cu. yds.	.60
70	Class 1 Excavation	150 cu. yds.	$ 1.20
	Class 2 Excavation	109 cu. yds.	2.00
	Borrow Excavation	55 cu. yds.	.80
	Subgrade	93,821 sq. yds.	.10
	Shoulders	18,854 lin. ft.	.15
	Reinf. Cem. Conc. Pavem. 9" unif. in depth	64,990 sq. yds.	2.87
	Reinf. Cem. Conc. Wear. Surf. Bridge Floors	1,749 sq. yds.	2.00
	Top Soil Borrow	3,263 cu. yds.	.70
	Foreign Borrow Excavation	4,714 cu. yds.	.70
71	Class 1 Excavation	10,660 cu. yds.	$ .75
	Class 2 Excavation	815 cu. yds.	2.00
	Subgrade	307,343 sq. yds.	.10
	Shoulders	58,350 lin. ft.	.15
	Reinf. Cem. Conc. Pavem. 9" unif. depth	271,009 sq. yds.	2.68½
	Reinf. Cem. Conc. Wear. Surf. Bridge Floors	3,196 sq. yds.	3.20
	Top Soil Borrow	8,310 cu. yds.	.50
	Approved Shale Borrow	14,618 cu. yds.	.65
72	Class 1 Excavation	50 cu. yds.	$ 1.00
	Class 2 Excavation	192 cu. yds.	2.50
	Subgrade	121,150 sq. yds.	.10
	Shoulders	22,716 lin. ft.	.18
	Reinf. Cem. Conc. Pavem. 9" unif. in depth	96,311 sq. yds.	2.83
	Top Soil Borrow	2,391 cu. yds.	.60
	Foreign Borrow Excavation	5,679 cu. yds.	.70
73	Class 1 Excavation	100 cu. yds.	$ 1.50
	Class 2 Excavation	68 cu. yds.	2.25
	Subgrade	83,450 sq. yds.	.10
	Shoulders	15,664 lin. ft.	.20
	Reinf. Cem. Conc. Pavem. 9" unif. in depth	72,218 sq. yds.	2.92
	Reinf. Cem. Conc. Wear Surf. Bridge Floors	729 sq. yds.	2.75
	Top Soil Borrow	1,528 cu. yds	.60
	Foreign Borrow Excavation	3,916 cu. yds.	.60
74	Class 1 Excavation	309 cu. yds.	$ .70
	Class 2 Excavation	283 cu. yds.	2.50
	Borrow Excavation	715 cu. yds.	.70
	Subgrade	189,400 sq. yds.	.10
	Shoulders	35,431 lin. ft.	.15
	Reinf. Cem. Conc. Pavem. 9" unif. depth	181,914 sq. yds.	2.73
	Reinf. Cem. Conc. Wear Surf. Bridge Floors	4,302 sq. yds.	2.25
	Top Soil Borrow	3,680 cu. yds.	.75
	Foreign Borrow Excavation	8,938 cu. yds.	.50
75	Class 1 Excavation	318 cu. yds.	$ 1.00
	Class 2 Excavation	138 cu. yds.	2.50
	Subgrade	188,147 sq. yds.	.10
	Shoulders	36,399 lin. ft.	.15
	Reinf. Cem. Conc. Pavem. 9" unif. depth	143,932 sq. yds.	2.63
	Reinf. Cem. Conc. Wear Surf. Bridge Floors	3,199 sq. yds.	1.50
	Approved Shale Borrow	9,150 cu. yds.	.70
	Top Soil Borrow	5,408 cu. yds.	.60
76	Excavation	950 cu. yds.	$ 4.00
	Earth and Stone Fill	9,100 cu. yds.	1.00
	Concrete Masonry	2,410 cu. yds.	17.00
	Reinf. Rods and Wire Mesh	348,000 lb.	.05
77	Class 1 Excavation	192,975 cu. yds.	$ .30
	Class 2 Excavation	4,734 cu. yds.	1.85
	Borrow Excavation	1,609 cu. yds.	.40
	Subgrade	44,200 sq. yds.	.15
	Shoulders	8,800 lin. ft.	.28
	Reinf. Cem. Conc. Pavem. 9" unif. depth	26,877 sq. yds.	3.30
	Reinf. Cem. Conc. Wear. Surf. Bridge Floors	775 sq. yds.	3.40
	Top Soil Borrow	1,306 cu. yds.	.70
	Foreign Borrow Excavation	2,250 cu. yds.	.70
78	Conc. Masonry Bldgs. and Pedestrian Underpass	300 cu. yds.	$ 22.00
	Reinf. Cem. Conc. Pavem. 9" unif. depth	3,065 sq. yds.	4.00
	Class 1 Excavation	325 cu. yds.	1.00
	Borrow Excavation	555 cu. yds.	1.00
	Class 2 Excavation	1,250 cu. yds.	2.00
82	Class 1 Excavation	100 cu. yds.	$ 1.00
	Class 2 Excavation	64 cu. yds.	2.00
	Subgrade	92,208 sq. yds.	.09
	Shoulders	17,289 lin. ft.	.22
	Reinf. Cem. Conc. Pavem. 9" unif. depth	54,208 sq. yds.	2.81
	Spec. Reinf. Cem. Conc. Pave. 9" unif. depth	38,000 sq. yds.	3.27
	Top Soil Borrow	1,223 cu. yds.	1.00
	Foreign Borrow Excavation	4,322 cu. yds.	.60
83	Class 1 Excavation	3,025 cu. yds.	$ .40
	Class 2 Excavation	159 cu. yds.	2.00
	Subgrade	96,993 sq. yds.	.10
	Shoulders	18,245 lin. ft.	.20
	Reinf. Cem. Conc. Pavem. 9" unif. depth	58,365 sq. yds.	2.96
	Spec. Cem. Conc. Pavem. 9" unif. depth	18,896 sq. yds.	3.26
	Reinf. Cem. Conc. Wear. Surf. Bridge Floor	1,192 sq. yds.	2.00
	Top Soil Borrow	2,811 cu. yds.	.60
	Foreign Borrow Excavation	4,635 cu. yds.	.50

TABLE IV—*Continued*

Contract No.	Description	Quantities	Unit Price Bid
84	Class 1 Excavation	935 cu. yds.	$ 1.00
	Class 2 Excavation	454 cu. yds.	2.50
	Subgrade	209,928 sq. yds.	.10
	Shoulders	38,396 lin. ft.	.15
	Reinf. Com. Conc. Pavem. 9" unif. depth	181,048 sq. yds.	2.90
	Spec. Cem. Conc. Pavem. 9" unif. depth	20,130 sq. yds.	3.30
	Reinf. Cem. Conc. Wear. Surf. Bridge Floors	785 sq. yds.	3.00
	Top Soil Borrow	2,967 cu. yds.	.70
	Foreign Borrow Excavation	10,000 cu. yds.	.65
86	Steel Plate Guard Fence	559.184 lin. ft.	$ .72
	End Anchorages	1,184 each	35.00
	Wood Shoulder Curb	140,179 lin. ft.	.17
	Sheet Metal Inlets	653 each	16.50
	Corr. Met. Pipe Shoulder Dra. 10"	16,566 lin. ft.	.90
88	Class 1 Excavation	983 cu. yds.	$ .95
	Class 2 Excavation	1,306 cu. yds.	2.00
	Borrow Excavation	4,972 cu. yds.	.45
	Subgrade	80,752 sq. yds.	.09
	Shoulders	15,141 lin. ft.	.18
	Reinf. Cem. Conc. Pavem. 9" unif. in depth	61,477 sq. yds.	2.72
	Spec. Cem. Conc. Pavem. 9" unif. in depth	19,275 sq. yds.	2.95
	Reinf. Cem. Conc. Wear. Surf. Bridge Floors	549 sq. yds.	2.00
	Top Soil Borrow	893 cu. yds.	.58
	Foreign Borrow Excavation	3,785 cu. yds.	.58
90	Class 1 Excavation	528 cu. yds.	$ 1.00
	Class 2 Excavation	102 cu. yds.	2.00
	Borrow Excavation	400 cu. yds.	.90
	Subgrade	50 452 sq. yds.	.10
	Shoulders	28,208 lin. ft.	.20
	6" Native Stone or Med. Cr. Aggr. Base Course (Var. Wid. 12' to 16')	16,599 sq. yds.	.77
	7" Native Stone or Mod. Cr. Aggr. Base Course (Var. 12' to 16')	19,326 sq. yds.	.87
	Reinf. Cem. Conc. Pavem. 8" unif. depth	3,023 sq. yds.	3.40
	Bit. Surf. Course CP-2, 2" dep. var. 14'-18'	28,774 sq. yds.	.55
	Foreign Borrow Surf.	730 cu. yds.	2.75
	Foreign Borrow Surf. for Maint. of Traffic	1,000 cu. yds.	2.50
	8" Native Stone or Med. Cr. Aggr. Base Course (Var. Med. 16' to 20')	11,504 sq. yds.	.97
92	Class 1 Excavation	135 cu. yds.	$ 1.00
	Class 2 Excavation	65 cu. yds.	2.00
	Borrow Excavation	150 cu. yds.	1.00
	Subgrade	72,745 sq. yds.	.10
	Shoulders	42,102 lin. ft.	.20
	16" Native Stone or Med. Cr. Aggr. Base Course (Var. Width 14' to 18')	56.345 sq. yds.	.80
	7" Native Stone or Med. Cr. Aggr. Base Course (Var. Width 16' to 18')	7,555 sq. yds.	.90
	8" Native Stone or Med. Cr. Aggr. Base Course (14' width)	7,445 sq. yds.	1.00
	Reinf. Cem. Conc. Pavem. 9" depth at sides and 7" in depth at center	1,400 sq. yds.	3.40
	Bit. Surf. Course HE-1	4 tons	10.00
	Bit. Surf. Course AT1—(Var. 14'-18' width)	48,550 sq. yds.	.35
	Bit. Surf. Course AT CP-2, 2 depth (Var. 14'-6')	22,795 sq. yds.	.60
	Foreign Borrow Surf. for Maint. of Traffic	500 cu. yds.	2.75
94	Right of Way Fence No. 1	17,220 lin. ft.	$ .6229
	Right of Way Fence No. 2	1,184,444 lin. ft.	.1092
	Right of Way Fence No. 3	324,326 lin. ft.	.1462
	Right of Way Fence No. 3 med.	54.624 lin. ft.	.1605
	Right of Way Fence No. 4	22,192 lb.	.1108
	Corner (or pull) Posts—Right of Way Fence Type No. 2	4,364 each	7.80
	Corner (or pull) Posts Right of Way Fence Type No. 3	1,502 each	8.61
	6.5' Line Posts	69,373 each	.6118
	8.5' Line Posts	22,110 each	.7678
	Posts for Right of Way Fence Type No. 4	4,760 each	.6209
	Unclassified Excavation	2,000 cu. yds.	3.00

DESCRIPTION OF TOLL BOOTHS

By GERALD R. TYLER

Chief Architect, Pennsylvania Turnpike Commission

ALONG the Turnpike there are ten locations where tickets will be sold. These tickets are classified according to types of vehicle, since the fares for heavy trucks are obviously more than those charged for passenger cars. Upon passing a ticket office at any point where access to the Turnpike is gained, the motorist is handed a ticket by the office attendant. This ticket has printed on it the rates from that office to all others where it is possible for the motorist to leave the Turnpike. Afterwards the motorist hands his ticket to the attendant at the station where he wishes to leave. The attendant at that station can then readily ascertain the amount of fare that is due and collect the correct fare from the motorist.

In determining the number of ticket offices to be erected, attention was given to the estimated peak loads of traffic, and to the likelihood of delays to motorists while waiting to pass the ticket office and gain access to the Turnpike. It was felt that the greatest loads of traffic would occur at the western and eastern ends. Therefore, six traffic lanes will be provided at Irwin, four at Carlisle and two at each of the intermediate stations. Five ticket booths will be installed at Irwin to accommodate six traffic lanes, while at Carlisle three booths serve four lanes. At each of the intermediate ticket offices there will be one incoming and one outgoing lane with a booth between. These intermediate ticket offices, as designed, are placed on ramps to one side of the Turnpike, so that through traffic is not impeded by them.

In connection with each ticket office a small utility building has been provided. These are located alongside the roadway and are connected to the ticket booths by

(*Continued on page* 70)

CONCRETE DESIGN, MATERIALS CONTROL AND SUPPLY

Railroad and Quarry Cooperation Insured Adequate Stock Piles

By IVAN L. TYLER
Concrete and Materials Engineer, Pennsylvania Turnpike Commission

EARLY in 1940 the Engineering staff of the Turnpike Commission realized that to maintain the required construction schedule it would be necessary to have an inventory made of all material sources to see if production schedules would insure an adequate supply of satisfactory materials, so that no delays in construction would result.

The requirements for each contract were tabulated, indicating the source of supply, daily production, stock on hand, method of delivery, railroad siding facilities, stocking facilities at the proportioning plants, and the daily requirements based on the schedule of construction for each contract.

The attached table lists the major contracts with the total requirements for each contract, daily requirements and other pertinent data. This tabulation indicates that 2,028,585 barrels of cement, 1,391,361 tons of stone, 843,887 tons of sand, and 14,785 tons of steel would be required to complete these projects. Based on expected working days, it would require 57,261 barrels of cement, 38,933 tons of stone, 22,583 tons of sand, 356 tons of steel daily. All of the stone, except 480,000 tons is being shipped by truck, as well as all steel except 4,400 tons. All sand, except approximately 40,000 tons, and all cement is being shipped by rail.

To transport these materials would require 6,762 cars for cement, 8,000 cars for stone, 16,077 cars for sand and 700 cars for steel, or daily requirements of 191 cars of cement, 242 cars of stone, 779 cars of sand, and 18 cars of steel.

These figures show that 1,230 cars of material would have to be handled daily, and since the empty cars would have to be moved daily, it indicates a movement of approximately 2,500 cars per day. By close cooperation with the railroads operating in the vicinity of the Turnpike, we have been assured of adequate switching facilities and to date sufficient materials have been furnished to service each contract, with no delays that can be attributed to lack of materials.

Stocking of Materials. — It was apparent that in order to maintain schedules and to avoid delays due to transportation, adequate supplies of materials be stocked during the Winter and early Spring. The problems of Winter production required careful study and it was soon apparent that to produce satisfactory coarse aggregate it would be necessary to wash the stone. The production of a number of the quarries was not adequate to supply requirements based on normal operations. Producers were contacted and production was increased by working on a two and three shift basis. In a number of cases it was necessary to recommend additional crushing and screening equipment.

The sites for storage were carefully selected and prepared to receive the aggregates by placing two-inch planks on the earth and building sides to prevent material from becoming contaminated with foreign matter.

To prevent contamination and to facilitate stocking, wooden truckways were provided on the stock piles. Stock piles were built up in four-foot layers to prevent segregation due to coning, and the materials are removed in the same manner.

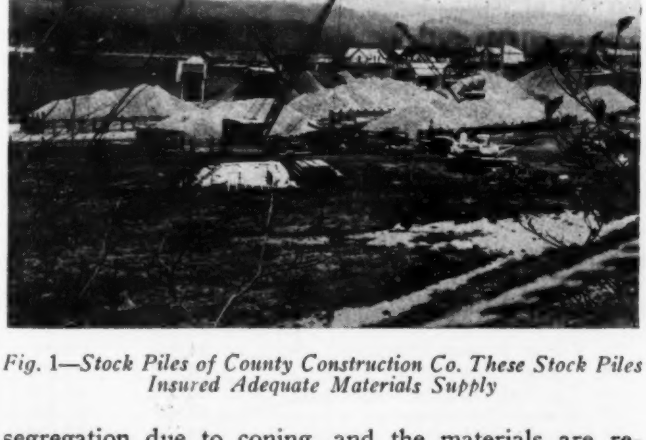


Fig. 1—Stock Piles of County Construction Co. These Stock Piles Insured Adequate Materials Supply

Plant inspectors were stationed at each proportioning plant to test materials as received as a guide to the producer so that rejections would be kept to the minimum.

Specification Requirements.—The specification for cement covered standard requirements and included a specific surface of not less than 1,600 square centimeters per gram and an auto-clave soundness of not more than 0.75 per cent expansion.

Fine aggregate specifications require stocking for at least 12 hours and permit only natural sands with a sodium sulphate soundness loss not exceeding 10 per

cent (A.A.S.H.O. M.T.-104-38) and meeting the following requirements:

Per cent passing	
⅜-in. square sieve	100
No. 4 square sieve	95–100
No. 16 square sieve	45–80
No. 50 square sieve	10–30
No. 100 square sieve	0–8
Per cent silt by weight	3.0
Strength ratio, per cent	90

The coarse aggregate for concrete is proportioned in two sizes and the stone shall have a per cent of wear (Deval) of not more than 5 per cent and a toughness of not less than 6 per cent. Not more than 5 per cent of flat or elongated pieces are permitted and not more than 1 per cent of shale. The loss by washing shall not exceed 0.5 per cent. Gravel, when permitted, shall contain not less than 40 per cent crushed particles and have a Los Angeles rattler loss of not more than 35 per cent. Coarse aggregate shall meet the following grading requirements:

Per cent Passing	2B Size	3A Size
2½-in. square sieve	....	100
2 -in. square sieve	....	90–100
1½-in. square sieve	100	35–70
1 -in. square sieve	90–100	0–15
½-in. square sieve	25–60	....
No. 4 square sieve	0–10	....

Control of Materials.—Cement is obtained from previously tested bins and each car is identified by car seals and acceptance cards placed in or on the car. These cards are the authority for using the cement.

Fine and coarse aggregate are tested in the field and samples representing the first shipment, rejected materials, and periodic samples representing each 1,500 tons of sand and 3,000 tons of coarse aggregate, are sent to the laboratory for confirming analysis and as a matter of record.

For the purpose of field control, a well equipped field laboratory with screens, sieves, balances and other essential equipment is provided. Forms for recording results are provided that include all necessary field tests data, including free moisture determinations to be used for the mix design.

In summation it appears that the close coordination between production, transportation and stocking has resulted in an adequate supply of satisfactory materials that will give a steady continuous supply in keeping with construction schedules.

Pavement Concrete Mixes.—Concrete for pavement is proportioned by absolute volumes of the materials which it contains. The essential requirements for concrete containing 2 in. maximum size aggregate are a maximum water ratio of 5½ gallons of water per bag of cement and a basic cement content of 1.56 barrels per cubic yard of concrete. The specifications provide for varying the quantities of aggregates within limits (the total absolute volume remaining constant) which will permit the most satisfactory proportioning—grad-

MATERIAL REQUIREMENTS FOR MAJOR TURNPIKE PROJECTS

		TOTAL REQUIREMENTS					DAILY REQUIREMENTS			
Cont. No.	Contractor	Bbls. Cement	Tons Stone	Tons Sand	Tons Steel	Tons Bitum.	Bbls. Cement	Tons Stone	Tons Sand	Tons Steel
47	Johnson, Drake & Piper	61.000	40,000	26,000	600	1,400	1,800	1,200	700	19
46	J. S. Swanger	76,400	44,860	35,080	550		2,025	1,250	900	15
39	Walker Brothers	11,400	7,500	4,650	12		600	419	233	2
67	States Engineering Co.	60,000	42,000	24,000	470	1.200	2,100	1,500	770	18
71	Union Construction Co.	112,320	78,237	40,865	700	1,300	2,690	1,970	985	17
58	N. B. Putman	63,500	43,000	25,500	430	4½	1,450	1,000	600	7
61	N. B. Putman	25,300	19,700	10,000	150	711	900	610	390	6
51	J. F. Bloomer	86,000	60,000	31,000	466		1,760	1,220	660	10
59	W. L. Johnson	41,415	27.874	16,592	308	33	1.725	1,160	690	13
83	W. L. Johnson	35,000	30,000	15,000	250		1,600	1,100	700	10
66	States Engineering Co.	37,000	26,000	15,000	300		2,100	1,500	770	5
82	Harrison Construction Co.	37,000	25,000	15,000	380		800	490	325	8
88	Walker Brothers	34.500	25,100	14,500	215		1,581	1,207	696	8
73	Walker Brothers	33,300	23,600	13,700	220		1,280	807	525	10
69	W. L. Johnson	30,300	21,140	12,600	244		1,500	1,000	600	12
75	McNally & Hobeck	70,000	60,000	30,000	700	1,600	2,000	1.100	720	13
57	County Construction Co.	108.000	65,000	44,000	600	33	2,700	1,500	750	16
84	Andrews & Andrews	85,000	52,000	33,000	500		2,200	1,400	700	13
50	Union Paving Company	95,000	63.000	40,500	600	7	2,000	1,350	750	15
56	Union Paving Company	26,500	18,500	11,000	170		2,500	1,730	1,000	15
70	Union Paving Company	34,000	28,000	14,000	270	1,250	2.500	1,730	1,000	15
49	Shullo Construction Co.	88,200	55,000	33,000	540	80	3,000	2,000	1,100	15
63	Tri-State Engineering Co.	68,000	42,000	28.000	575	750	1,600	1,000	600	12
72	Wm. O'Neil Sons	49,800	36,300	20,400	400		1,800	1,250	700	14
77	Frank Mashuda	16,150	10,550	6.500	75		1,800	1,250	700	14
62	Midwest C. & A. Company	63,000	45,000	27,000	410		1,800	1.290	770	15
74	A. Eidemiller	73,000	48,000	32,000	550	10	1,800	1,200	800	15
60	Wm. D. Vogel	50.000	30,000	20.000	600	2,000	2,000	1,400	900	15
68	Baldwin Bros. Paving Co.	55,000	34,000	22,000	3.500	80	1,400	900	550	9
	TUNNEL PROJECTS									
12	Arundel Corporation	75,000	63,000	33,000	*........		500	450	240	*....
13	Hunkin Conkey Co.	60,000	40.000	30,000	*........		600	500	300	*....
17	Guthrie-Marsch-Peterson	68,000	42,000	27,000	*........		1,000	800	450	*....
18	Bates & Rogers Company	95,000	70,000	40,000	*........		1,300	900	560	*....
24	Mason & Hanger	48,000	35,000	25,000	*........		400	350	200	*....
25	B. Perini & Sons	56.500	40,000	28,000	*........		450	400	250	*....
	Totals	2,028,585	1,391,361	843,887	14,785		57,261	38,933	22.583	356

* Previously shipped.

ing, particle shape, surface texture, and other characteristics being considered. Appropriate changes in proportions are provided for pavement concrete such as bridge wearing surfaces in which 1 in. maximum size aggregate is used.

For the range of aggregates found on Turnpike construction, the fine aggregate makes up 34 to 37 per cent of the total quantity of aggregate in the batch when the 2-in. aggregate is used.

Batching.—Cement and aggregates are batched by weight. Cement is weighed in an individual batcher and aggregates generally in a cumulative batcher provided with three beams or equivalent springless dial indicator. Aggregate batch weights are corrected for contained moisture by applying corrections found by field determinations. An average batch will have the following weights of materials:

Material	34E	27E
Cement	810 lb.	643 lb.
Mixing Water	46 gal.	36.5 gal.
Sand (Oven dry weight)	1620 lb.	1286 lb.
2B Stone (Oven dry weight)	1610 lb.	1276 lb.
3A Stone (Oven dry weight)	1315 lb.	1044 lb.

The weights vary somewhat, of course, due to the water content in the aggregates. The sand weights vary 5.0+ per cent, 2B rock 1.0+ per cent, and 3A rock 0.5+ per cent.

Scales are calibrated daily in order to insure accuracy of batching. Water batchers at the mixers are subject to frequent calibration.

Mixing Water Control.—Control of the water cement ratio is recognized on Turnpike construction as being of paramount importance in obtaining durable pavement. As is quite generally agreed, the accurate control of this important factor is one of the most difficult operations encountered by the paving engineer. The method of control adopted for the Turnpike involves frequent moisture determinations on all aggregates with close control of batched water, and consistency determinations on concrete by slump measurements at the mixer. By intelligent use of information obtained from these operations, it has been possible to place concrete pavement with the assurance that quality of concrete, as measured by water cement ratio, is actually known. Typical results obtained are shown by the graph of operations on one paving contract, Figure 4.

Test Records.—One set of four 6 by 12 in. concrete test cylinders for compressive strength and two 6 by 8

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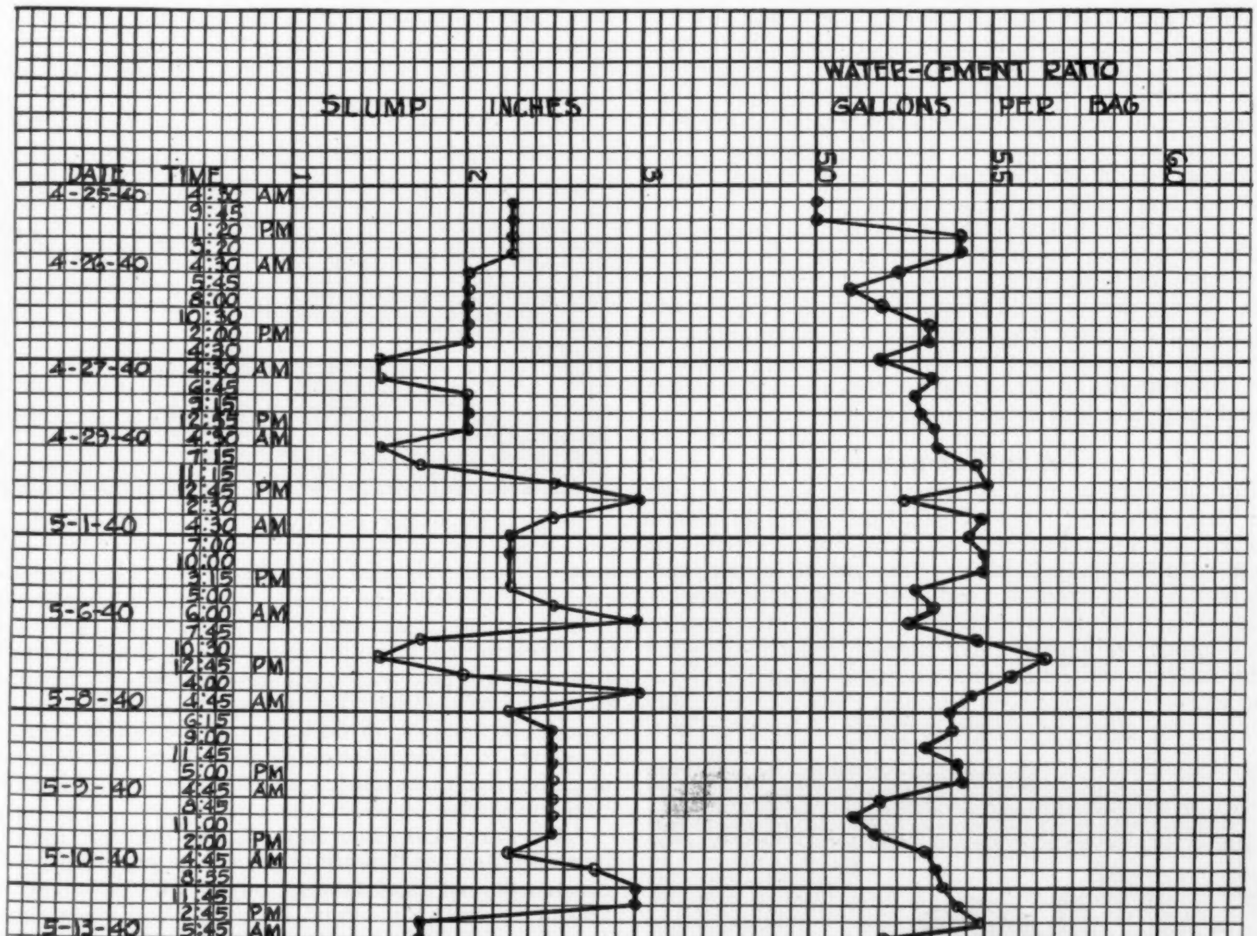

Fig. 4—Typical Graphs of Calculated Water-Cement Ratio Determined at Batch Plant and Slump Measured at Mixer. In These Curves There is No Correction for Moisture Loss During Transportation From Batching Plant to Paver

SELECTION OF BRIDGE STRUCTURES FOR ECONOMY

Pictures Show Typical Drainage, Overhead, and Underpass Designs

By RICHARD F. GRAEF

Chief of Bridges, Pennsylvania Turnpike Commission

THE bridge program of the Pennsylvania Turnpike covers quite completely the field of short span bridge construction. In making studies for the solution of the various problems encountered, it was neecssary that thorough consideration be given to every possible type of structure satisfying the conditions encountered in order that the proper conclusions be drawn, since in most cases the solutions were to be applied to large numbers of cases. This meant that the studies being performed were applicable to construction representing many times the cost of a single structure and a difference, slight for the case of a single bridge, represented a large sum in the actual project.

This condition has no better example than that of the grade separation problem, particularly as concerns structures carrying intersecting roads over the Turnpike. Before design could be started on any single grade separation structure it was necessary to make extensive studies in order to select the cheapest structure fulfilling the requirements of structural soundness, safety to the traveling public and satisfactory appearance.

Types Compared

For the purpose of carrying intersecting roads over the Turnpike, eight types of structures were completely studied and several others, sufficiently to ascertain that they could not compete in ecenomy with the types upon which the more elaborate studies were made. It was required that in all cases abutment faces be at the edge of the shoulder, giving a clear normal distance between abutment faces of 78 ft. The types given full consideration were:—two span steel I-beams, Plate girders, Pony trusses, two span reinforced concrete T-beams, single

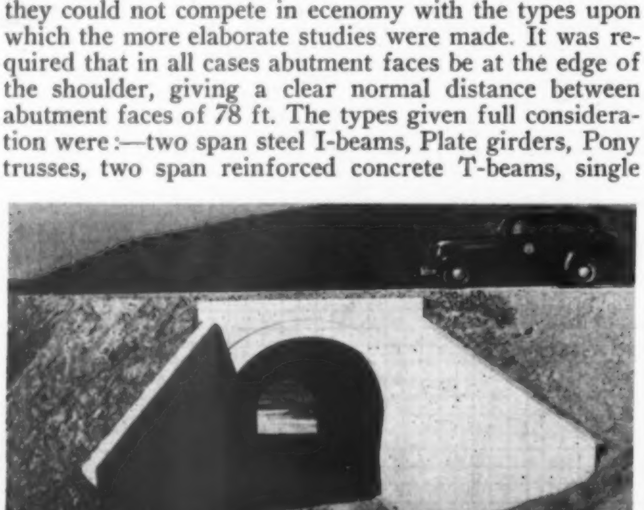

Fig. 1.—Typical Arch Underpass for Form Crossing

span reinforced concrete girders, single span reinforced concrete rigid frames, two span reinforced concrete rigid frames and single span structural steel rigid frames. In this study it was necessary to differentiate between crossings of moderate skew and those of great skew since the same solution did not apply to both.

An application of all types to those intersections having skews ranging from 0 degs. to 30 degs. indicated that where foundation conditions permitted its construction, the two-span reinforced concrete rigid frame gave the cheapest solution. Twin-span reinforced con-

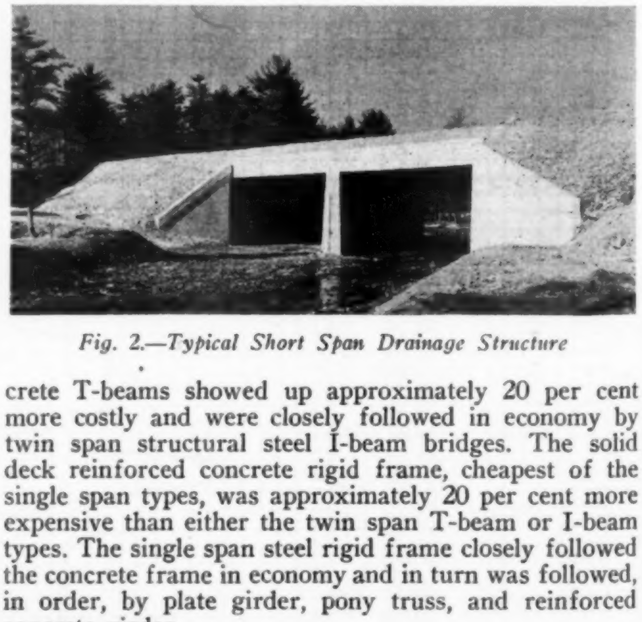

Fig. 2.—Typical Short Span Drainage Structure

crete T-beams showed up approximately 20 per cent more costly and were closely followed in economy by twin span structural steel I-beam bridges. The solid deck reinforced concrete rigid frame, cheapest of the single span types, was approximately 20 per cent more expensive than either the twin span T-beam or I-beam types. The single span steel rigid frame closely followed the concrete frame in economy and in turn was followed, in order, by plate girder, pony truss, and reinforced concrete girder.

After careful consideration, it was decided that certain very definite limitations should be placed upon the construction of rigid frame bridges. First of these was that in no case should rigid frames be built except upon foundations certain to be unyielding in character. This eliminated all chance of stresses due to settlement of one support relative to the other, Second, it was required that foundations for rigid frames be poured neat into excavation in rock so that all stresses due to horizontal displacement of one support relative to the other would be eliminated. Third, it was decided that 30 degs. should be the maximum skew for which any rigid frame should be built on this project, although frames of much greater skew can be successfully designed and con-

structed. This limitation was invoked for two reasons. First, there was was a desire to keep the design of the frames on a conservative basis in view of the large number to be constructed simultaneously and, second, the depth of section required increases rapidly beyond this skew and much of the economy of the frame is lost. In order to reduce temperature stresses, all of the frames, with the exception of the one ribbed type frame used, were designed with hinges at the bases of the legs.

Although reinforced concrete rigid frames were only slightly cheaper than steel frames (and under some conditions the steel frames might have shown a slight advantage in cost) it was decided that reinforced concrete frames should be used throughout. The concrete frame has a very distinct advantage over the steel frame other than the saving in maintenance due to the absence of the necessity for painting which exists in steel structures. In the case of concrete rigid frames, because of the proportions and the loads for which they were designed, approximately 75 per cent of the stress is due to dead load. Hence, a 100 per cent increase in live load produces an increase in total stress of only 20 per cent. In the case of the steel frame, this ratio of live load to dead load stresses is almost 1:1 so that an increase of 100 per cent in live load increases the total stress almost 50 per cent. Consequently, the concrete frame at approximately the same cost results in a structure much

Fig. 3.—General View of Clear Creek Structures

less sensitive to live load and possessing a true factor of safety much higher than the steel frame.

Skews

For skews 30 degs. to 45 degs., it was found that twin span reinforced concrete T-beam structures were the cheapest. Twin span I-beam structures were only slightly more costly. Plate girders were more than 50 per cent higher in cost. The spans for these skews were too great to permit the use of single span reinforced concrete girders of such depths as to lend themselves to satisfactory architectural treatment and the appearance of pony trusses was considered undesirable. Skews greater than 45 degs. resulted in concrete T-beams of undesirable length. Specifications limited the use of rolled I-beams to 60-ft. span which was reached for twin spans at approximately 50 degs. skew. This eliminated from consideration all save plate girders of one or more spans for skews greater than 50 degs. It was not felt that any span encountered warranted the use of "tied arches".

Intersecting Roads Over

In determining the type of overhead structures to be used, it was considered desirable to eliminate the use of piers in the middle strip of the Turnpike in all cases where differences in cost were not excessive. Although twin span structures were cheaper than those of one span in all cases, where rigid frames could be used the differences were not great and consequently the following general procedure was adopted:

Fig. 4.—Continuous I-Beam, 3 Spans of 69 ft. 0 in.

1. Skews of 30 degs. or less.
   (a) Where foundation conditions met the requirements described above, reinforced concrete rigid frames were used.
   (b) Where foundation conditions did not warrant rigid frame construction, reinforced concrete T-beams were used except that plate girders were used in sections where only a few middle piers would otherwise occur.
2. Skews greater than 30 degs., but less than 55 degs.
   Plate girders were used except that in sections where middle piers were required in other structures twin span reinforced concrete T-beams were used for skews up to 45 degs.
3. Skews greater than 55 degs.
   Twin span plate girders were used.

The above procedure resulted in the use of the following numbers of structures of the various types:

45 Single span rigid frames.
8 Single span rigid frames at interchanges.
24 Single span plate girders.
20 Twin span T-beams.
2 Twin span plate girders.
1 Three span plate girder.

Fig. 5.—Typical Single Span Plate Girder Overhead

The three span plate girder was used for a crossing of 69 degs. 15 min. skew, requiring a special solution involving the use of square-off spans.

All plate girder structures were given special architectural treatment predominated by large end pylons of concrete hiding the ends of the girders. Aluminum paint was used on the steel so that the concrete and steel coloring blends in the structure. The twin span T-beam structures all have similar architectural treatment with terminating pylons and pier pylons running up through the parapets. The rigid frames are of two

Fig. 6.—Three Span Plate Girder

general types, one having abutment pylons and treated to appear as a restrained beam, the other having plain wings with heavy batter, the entire assembly emphasizing the rigid frame.

Intersecting Roads Under

Structures carrying the Turnpike over intersecting roads in most cases have a clear span of 22 ft., although some have spans of 24 ft. and a very few have greater spans. It was decided that where the distance from grade to grade was the minimum or nearly so, reinforced concrete T-beams should be used for these structures. There are a number of cases, however, where the

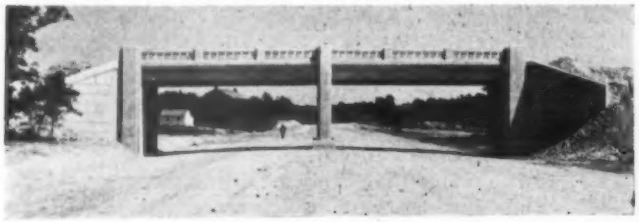

Fig. 7.—Typical Twin Span T-Beam Overhead

distance from grade to grade is considerably greater than minimum. For these cases, it was found that barrel arches gave a very economical solution. One of these has a span of 63 ft. crossing a stream and a township road. For this location, a two-story structure with a stream carried beneath the roadway, and separate structures for stream and roadway were considered. The single arch showed a saving of more than $10,000 over either of the other two types. The arch underpasses have

Fig. 8.—Typical Rigid Frame Overhead, Restrained Beam Type With Angle Wings

the added advantage of presenting a larger apparent opening than do the T-beam or rigid frame types because of the necessity of increasing span to obtain minimum clearance at the roadway edges.

Special Designs

There were a number of problems involving combinations of stream and road crossings. In general these were solved by the use of multiple span or viaduct construction. Chief of these is the one near New Stanton where the Turnpike crosses Little Sewickley Creek, the Pennsylvania Railroad and State Highway Route 119. This structure has a total length of 600 ft. The main span is an open spandrel reinforced concrete arch of 170 ft. clear span. The arch is flanked on each end by

Fig. 9.—Typical Rigid Frame Overhead, Restrained Beam Type With "U" Wings

a span of 50 ft., then one of 82 ft., and an end one of 50 ft. The 82 ft. spans at each end are reinforced concrete rigid frames of rib type with legs hinged at their bases. The remaining 50 ft. spans are reinforced concrete T-beams monolithic with the rigid frames and simple supported at the arch and abutment ends. These beams have curved soffits giving the appearance of three span rigid frame approaches at each end. Making the outside spans of each approach group T-beams restrained at one end eliminated the high temperature stresses involved in three span rigid frame construction. The one end restraint reduced the positive moments sufficiently to permit design of the beams without great loss

Fig. 10.—Typical Rigid Frame Overhead, Rigid Frame Type

in economy. This structure is probably the most imposing one on the Turnpike. It is shown in figure 11.

One of the more interesting problems involving combination stream and road crossings is the one near Everett where the Turnpike crosses Clear Creek and State Highway Route 26 at points only a few hundred feet apart. The distance from streambed to Turnpike grade is 90 ft. A viaduct approximately 800 ft. long

Fig. 11.—Open Spandrel Arch Flanked by (1) Reinforced Concrete T-Beams Poured Monolithic With Rigid Frames, (2) Rigid Frame of Rib Type, and (3) T-Beam Monolithic With Rigid Frames

would have been required if that type of construction were used. It was found, however, that a barrel arch of two spans of 52 ft. clear each and a barrel arch over the highway would give a solution at a cost almost exactly the same as that of the viaduct. Due to the greater rapidity with which the barrel arches could be designed and constructed, and because speed was of unusual importance, the arch construction was decided upon. The stream arches are 305 ft. long and have a fill of 70 ft. over the crown. They contain approximately the same volume of concrete as New Stanton viaduct. The highway arch has slightly more than 40 ft. of fill over the crown and is approximately 200 ft. long.


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SIGNING THE TURNPIKE

Typical Interchange and Tunnel Approach Setting Explained

By G. R. BRITTON

Special Engineer in Charge of Signs, Pennsylvania Turnpike Commission.

ENDEAVORING to make use of all possible information relative to sign legibility, in order to ascertain the most effective types of signs, the Pennsylvania Turnpike Commission, jointly with the Bureau of Street Traffic Research of Yale University, conducted a series of tests of letter legibility. These tests were conducted by Dr. T. W. Forbes of the Yale Bureau for Street Traffic Research* and by Robert S. Holmes of the Turnpike Commission who also handled all subsequent design and planning of the Turnpike signs. Efforts to keep the signing geared to the speeds to be allowed have been under the direction of Mr. Charles M. Noble, Special Highway Engineer for the commission.

Electric illumination not being feasible because of the rural conditions and the scattered locations of most of the signs, all signs, except a few of the minor ones, have been reflectorized.

The size of the lettering, and consequently, the size of each sign, was determined by the importance of the message. A maximum of 18 in. in height for letters was used in some cases.

Many motorists have complained about three major faults in traffic signs; 1, that signs have not been large enough to place the message before the motorist for a sufficient length of time for the message to be read and understood; 2, that signs were not placed sufficiently far in advance of the condition indicated on the sign to allow the motorist to be prepared; and 3, that important messages were not repeated to make sure that the motorist had not missed the first message. Every effort was made to avoid these conditions on the Turnpike.

All signs were designed, and are being placed to inform the motorist clearly, emphatically, and sufficiently far in advance of every special condition, exit, interchange, tunnel, etc. Emphasis was gained by repetition of important messages, as well as in the size of the sign, and it was endeavored to space the signs sufficiently far apart so that the effectiveness of any sign would not be diminished by having the next sign appear before the message on the first was read and understood.

Illustrative of the general placement and types of signs which will be seen on the Turnpike are the plans showing those in the vicinity of Bedford interchange, an intermediate interchange, and typical signs in the vicinity of a tunnel.

Interchange Signing—Referring to Fig. 1, for example, a motorist on the Turnpike approaching the Bedford interchange is informed at two miles in advance, one mile in advance, and again at one-half mile, that Bedford interchange (Interchange No. 5) and the exit to U. S. Route 220, are ahead. As he nears the interchange, a sign "Keep Right for Exit" directs him to use the additional decelerating lane on the right if he desires to leave the Turnpike. Approximately 400 ft. in advance of the offbound ramp, he is again informed of the interchange number, the intersecting route number, and is informed by an arrow that the turnout is to the right. At the beginning of the offbound ramp, he can see this information repeated on the ramp itself, and from the same point, another sign is visible with the information that Harrisburg (or Pittsburgh) is straight ahead on the Turnpike. As a result of the size, spacing, and repetition of the signs it is felt that the motorist will be furnished sufficient information at all times to enable him to decide in ample time if he desires to leave the Turnpike at this particular interchange, and that he has been definitely informed where to make the turn. After the turn is made, the motorist is cautioned by "Merging Traffic Ahead" to watch for traffic as the ramp merges with the access road. Next, a sign at the Ticket Office directs him to "Stop—Pay Fare." Beyond the ticket office he is warned by "Stop—Thru Traffic" where the access road connects with the existing state highway. And stopping, he is informed that he is entering U. S.

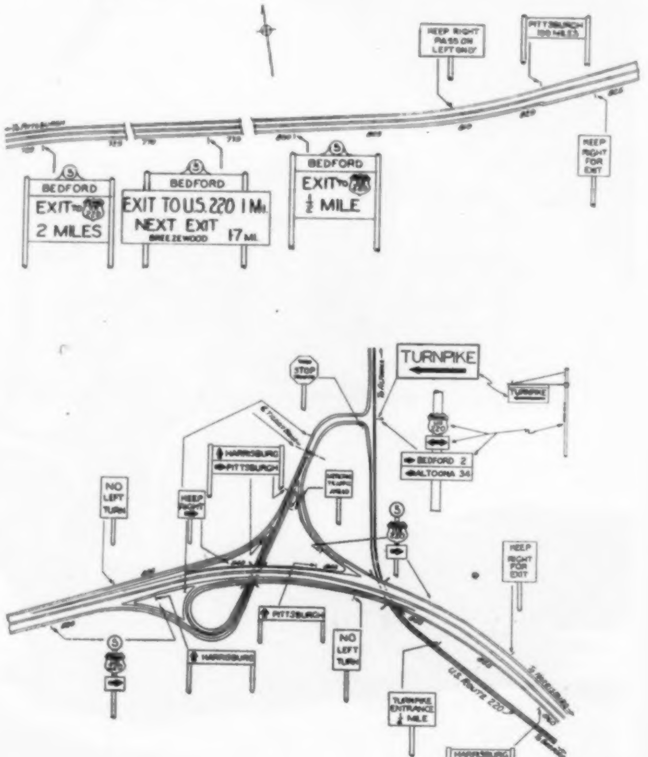

Fig. 1.—Bedford Interchange Showing Typical Interchange Signing

*Paper presented before Highway Research Board at the 19th Annual Meeting, December 5-8, 1939, on "Legibility of Highway Destination Signs" by Dr. T. W. Forbes, Yale Bureau for Street Traffic Research, and R. S. Holmes, Pennsylvania Turnpike Commission.

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Route 220, that Bedford is 2 miles to the right and that Altoona is 34 miles to the left.

A motorist desiring to enter the Turnpike is informed while on the state road (if conditions necessitate that information), that the Turnpike entrance is one-half (or one-quarter) mile ahead. The entrance itself is marked by a sign with a large directional arrow. Passing through the ticket office where he is directed to "Stop—Get Ticket" he is informed in advance of the onbound ramps that he is to take the ramp to the right for Pittsburgh, and the ramp straight ahead for Harrisburg. This information is repeated on the ramps, where the motorist is also directed to "Keep Right" on the extra accelerating lane. Entering the Turnpike, he is cautioned: "No Left Turn." Confirming his destination, he is informed that Pittsburgh (or Harrisburg) is ahead, and the mileage is given. Leaving the interchange, he is reminded by a final sign of the general rules of the road; "Keep Right—Pass on Left Only."

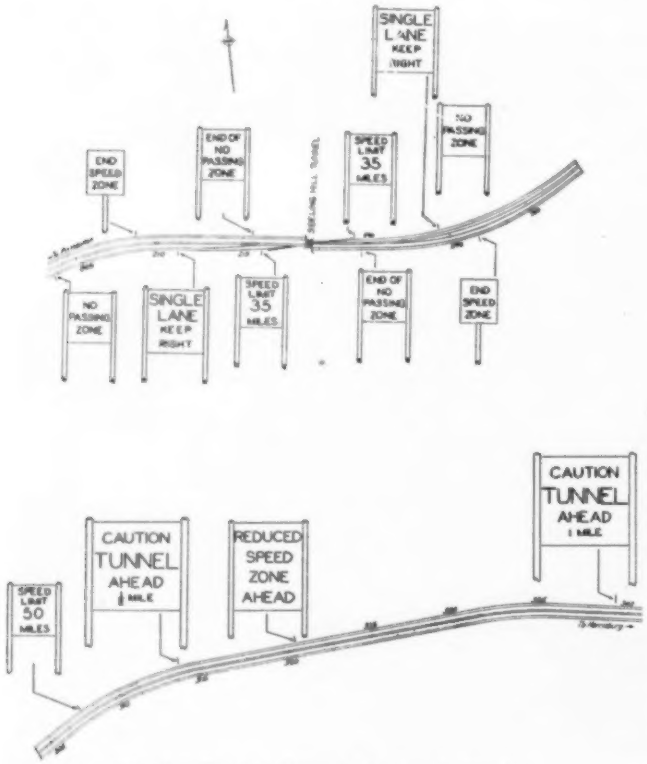


Fig. 2.—Typical Tunnel Approach Signing

Tunnel Approach—A motorist approaching a tunnel on the Turnpike is informed of that fact when one mile away. He is next cautioned that a reduced speed zone is ahead, followed by the information that the tunnel is now only one-half mile ahead.

Notice of "Speed Limit 50 Miles" is followed by the information that he has entered a "No Passing Zone." Approaching the tunnel portal, he is informed that this is "Single Lane—Keep Right," and at the tunnel portal the speed limit is reduced to 35 miles per hour.

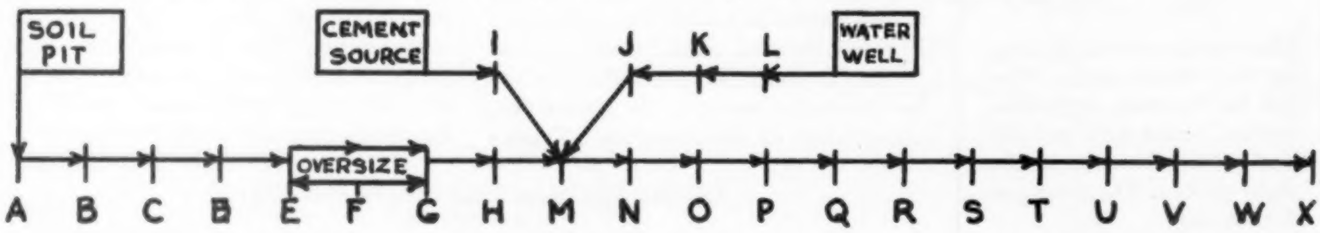
Emerging from the tunnel, he reaches the "End of No Passing Zone," as soon as his eyes are adjusted to the change from the artificial tunnel illumination to daylight, and then "End of Speed Zone."

Other Signing—In addition to the signs at the interchange and tunnels, reflectorized curve symbols are being placed in advance of all curves.

The angle of the arrow symbols on these signs indicates the degree of the curve ahead, ranging from an arrow having a slight angle, indicating a curve of from 1 deg. 00 min. to 1 deg. 45 min, through various increasing angles in the symbol to an arrow with the maximum of a 90 deg. angle which indicates a curve ahead of from 4 deg. 30 min. to 6 deg. 00 min. In addition, the size of the sign varies from a 24-in. sign used for minor curves to a maximum 48-in. sign used to put a 'punch' into the message informing the motorist that he is approaching one of the sharpest curves on the Turnpike.

All signs are being placed clear of the Turnpike shoulders, and the rugged country through which the highway passes has placed many obstacles in the way of setting the signs, requiring many careful readjustments of the original plans in order to avoid local conditions which would offset the effectiveness of the signs. Particular attention is being paid to setting the signs so that all possible "mirror back," or headlight reflections from the faces of the signs will be avoided within the maximum distance at which the signs will normally be read at night. In endeavoring to avoid these reflections, a "Sign Setting" instrument was developed to allow each sign to be quickly set at the proper angle in relation to the point on the pavement at the maximum legibility distance of that sign. Much attention is also being paid to the height at which the signs are being placed above the pavement, and to the offset distance from the pavement in order to secure the maximum effectiveness of the reflecting materials on the signs in the headlight beams. Each setting is practically an independent problem.

Correction—To Fig. 19, pg. 41, May, 1939, issue. Captions were omitted from that issue.



a. 1½ yd. dragline
b. 2—4-yd. dump trucks
c. Grizzly, hopper and plate feeder
d. Belt conveyor
e. Rotary screen
f. Clay disintegrator
g. Belt conveyor
h. Weighing hopper
i. Cement truck
j. Pump, measuring device, and spray for water
k. Water storage tank
l. Water tank truck
m. 4000 lb. pub mill and 205 hp. stationary engine
n. Batch trucks (Variable number)
o. Truck scale
p. 2 spreading machines
q. 1 sheepsfoot roller
r. 1 Motor grader
s. 1 Tooth harrow
t. 1 Pneumatic roller
u. Same motor grader
v. Wet cotton mats
w. 1 Asphalt distributor (cure-prime coat)
x. Double asphalt surface treatment

UTILITY EQUIPMENT FOR TUNNEL OPERATION

Electrical and Mechanical Accessories for Ventilation, Lighting and Plumbing Described

By EDGAR C. MARTY

Chief Mechanical and Electrical Engineer, Pennsylvania Turnpike Commission

VENTILATION of the Turnpike tunnels will be accomplished essentially as has been done in the ventilated vehicular tunnels which have been constructed previously at various points.

The fans being installed for this purpose are among the largest which have been built for this type of service, in fact the manufacturer states that these fans are the largest fans which have been tested at their plant. All are of the same geometrical design and of the same dimensions. The variations in total air pressure and volume required for the various tunnels was accomplished by variation in speeds suited to the conditions of each tunnel.

There are four fans installed for each tunnel, two at each portal, in an especially constructed portal ventilation building. Ray's Hill tunnel is the exception to this, in which case, due to the shortness in length, two fans are being installed at the west portal only. However, this occasioned conditions in volume and total pressure requirements which made these two fans the highest speed and largest volume in output as well as total pressure.

The fan speeds vary so as to produce a volume of approximately 190,000 cu. ft. per min. each at 1 in. total pressure water gauge for Blue Mountain tunnel to 311,000 cu. ft. per min. each with approximately 4 in. total pressure water gauge for Ray's Hill tunnel. In the case of Sideling Hill tunnel, the volume for each fan is approximately 313,000 cu. ft. per min. each with about 2 in. water gauge.

The individual fan wheels are approximately 9 ft. 4 in. in diameter with a double inlet width of 6 ft. 4 in., the fan shaft being 10½ in. in diameter in the wheel hub, and being tapered to bearing diameters at the ends with a total shaft length approximating 19 ft. 6 in. Figure 1 herewith indicates the general proportion of the fan wheels.

Fan Test—Since all fans, 26 in number for aii tunnels, are the same geometrical design and dimensional construction, it was only necessary to test one fan. For this purpose, one of the fans was set up at the plant of the manufacturer and tested in accordance with the standard test code of the National Association of Fan Manufacturers and the American Society of Heating and Ventilating Engineers. Figures 2 and 3 indicate the magnitude of the test set-up. The test requirements necessitated the construction of the outlet tube indicated by the picture, which was 12-ft. 9-in. in diameter and approximately 130 ft. long. The test fan showed that the installed fans will easily meet the anticipated requirements and specification conditions.

CO Control—The operation of the fans will be such as to maintain the tunnel atmosphere at a CO content not to exceed 4 parts in 10,000. The measurement of CO content will be by means of CO analyzers and recorders. The analysis produced by the automatic analyzer, being automatically recorded on the instrument chart of the recorder.

An analyzer and calibrator will be installed in each tunnel portal ventilation building. This equipment will draw samples from various points in the tunnels, each analyzer drawing from its half of the tunnel except in the case of Ray's Hill where samples will be drawn from the entire tunnel to the west portal building, where the analyzers will be located.

At the points in the tunnels where the samples are drawn niches will be installed, in each of which will be installed suitable filters to filter dust and foreign material from the air as it enters the CO sampling piping system. The samples are drawn to the analyzers by means of vacuum pumps. Each analyzer reports its analysis automatically and by wire to its recorder instrument which is located near the supervisor's station in the portal ventilation building selected for this purpose, one for each tunnel with the exception of the case of Blue Kittatinny Mountain tunnels where one supervisor will observe and control the operation of the ventilation equipment in both tunnels. Therefore, in this case, the supervisor will have four recorders at his station.

As the CO content varies, the supervisor will be able to control the operation of all fans in a given tunnel for his station. If he finds that one fan at quarter speed is required to maintain the CO content at the desired concentration, he will be able to press a button for quarter speed of the fan he may select at each portal and control equipment will bring the fan into operation at that speed. Likewise, other speeds of the fans (full speed and half speed) will be operated by the supervisor from his station by pushing button for control.

Utilities Operation

The basic design of volume requirement upon which fan capacity was determined assumed provision for 175 cu. ft. per foot of length per tunnel at the full speed of each fan with all fans in operation.

The horsepower of the motors required to drive the fans at their individual full speed varies from 40 hp. per fan motor at Blue Mountain tunnel to a maximum of 250 hp. per fan motor for Ray's Hill tunnel. The full speed fan motors are single speed motors and it is anticipated that full speed of the fans will be required at only a small fraction of 1 per cent of the time. This indicates the margin of safety which is pro-

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vided in order that the tunnel atmosphere may be maintained at a very safe and fresh condition. The motors for half and quarter speed operation of the fans are two-speed motors; thus, two motors are provided for each fan. The full speed motor being the single speed type and the other for half and quarter speeds. The two speed motors vary from approximately 2 hp. for the smallest at Blue Mountain tunnel to a maximum of approximately 40 hp. for Ray's Hill.

The control of the dampers will be automatic and tied in with the starting cycle of the fan motors, each damper being provided with a damper operating mechanism consisting of a motor speed reducer and shaft with drums for winding cable connected to the dampers. The operation of the dampers will be in a predetermined cycle required with the acceleration and deceleration conditions of the fans and drives.

In addition to housing the tunnel ventilation equipment, the portal ventilation buildings will house emergency lighting equipment consisting of gasoline motor driven generators, one for each tunnel, pump for accumulating water for the tunnel roadway flushing system, well pumps, toilet facilities, heating equipment for each building, air compressors for building service, and miscellaneous other items.

The flushing of the tunnel roadway drainage galleries, etc. will be accomplished through water stored in a head supply tank located suitably on the mountain side above one of the tunnel portals which the tank will serve. These tanks are set at sufficient elevation to provide the equivalent of an average fire stream both in quantity and pressure, being approximately 120 gal. per min. at

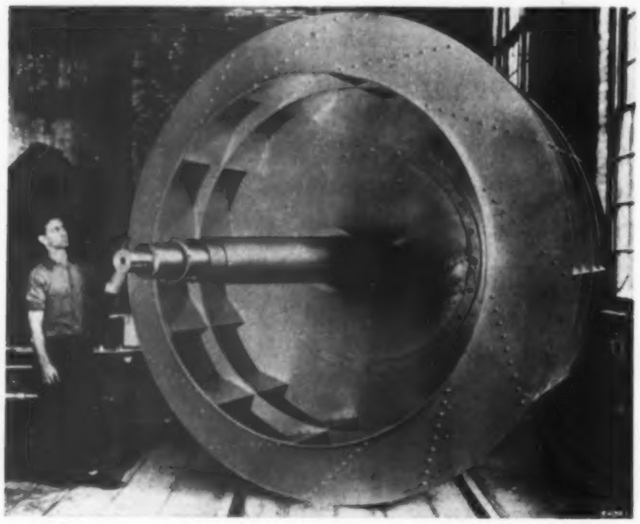


Fig. 1.—Relative Size of Fan Wheel Indicated by Man Standing Alongside

about 55 lb. per sq. in. pressure. The water is supplied to various points in each tunnel through a line from the head supply tank to the tunnel and through the tunnel in the drainage galleries with taps located at 250 ft. intervals on the sidewalk side of the tunnels.

In view of the absence of public water supply, it was necessary to drill deep wells for each tunnel portal building in order to provide potable water for drinking purposes and proper water for sanitary purposes. This was also necessary for the ticket offices, and maintenance buildings. These wells are of course provided with deep well pumps and pressure tanks which provide a stable source of potable water under automatic supply. In this connection it was, of course, necessary to provide sewage disposal in the form of septic tanks and drain fields, which facilities were installed for each of the portal buildings, ticket offices and maintenance buildings.

The heating equipment consists of low pressure vapor heating boilers, one for each building and in the case of the tunnel portal ventilation buildings, the firing of these boilers will be by means of stokers which will be entirely automatic in operation and will take the coal (anthracite for the easterly tunnels and bituminous for the westerly tunnels) from the bins, deliver it to the fire and the ash will be, in each case, disposed of in an ash pit which under average conditions will serve approximately two months accumulation.

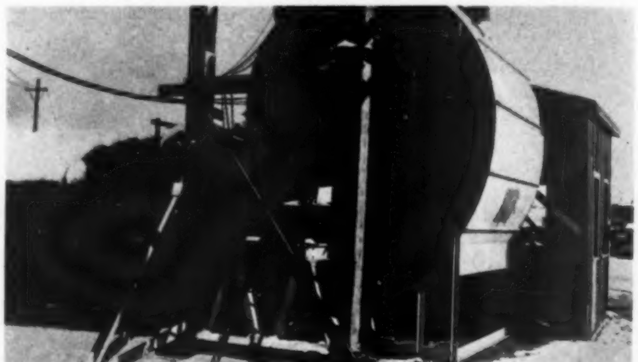


Fig. 2.—Fan End of Test Setup

Considering the type of equipment installed in these buildings and the fact that the supervisor will control the equipment from one station and will be essentially occupied with that service, automatic operation was considered essential. This is particularly true in the case of the remote buildings at which interval inspection will be the rule without a permanent attendant.

The point of particular interest which will be observed with a great deal of attention is the choice of mercury lamps for the lighting of the tunnels themselves. This type of lighting has been in industrial use for some considerable time and in certain instances street lighting installations have been carried out with this type of lamp. However, the Turnpike tunnels are the first vehicular tunnels in which mercury lighting has been used. Another point of especial interest is the fact that to gain maximum illumination efficiency and maximum freedom from glare, open luminaires are being installed in the tunnels for this mercury lighting.

In addition to the mercury lighting which will provide the normal lighting of the tunnels, emergency lighting located in the cove will be provided which will automatically function in case of power failure or any other interference with the operation of the mercury lamps. This emergency lighting will be provided by means of incandescent lamps.

The mercury lamp luminaires are located on the center line of each lane and are alternately spaced approximately 37½ ft. between centers with closer spacing in the area at and near the portals.

The approach lighting to the tunnels for a distance of approximately 1,300 ft. from each portal and the lighting of the interchanges will be by means of sodium vapor lamps. These lamps will be installed approximately 25 ft. above the roadway at a point 5 ft. over the edge of the pavement. Intervals will be least at the portal and increased leaving the portal. In the case of the tunnels and at the interchanges the spacing was determined in order to best suit local conditions. Sodium

lights are providing distinctive type of lighting at the interchanges as well as the tunnel portals and by this means the driver will clearly observe approach to these areas a considerable distance before reaching them.

The sources of power for the tunnels, portal buildings, ticket offices and maintenance buildings will be from the power companies serving the particular areas. Each tunnel will be provided with a substation in which single phase transformers will be installed. The transformers will be designed with primaries suitable for the incoming voltage and secondaries in each transformer providing 2,300 volts and 440 volts with taps on the 440 volt winds for 220/110 lighting service. The single phase transformers will be connected delta so that open

Fig. 3.—Showing Length of Pipe Setup on Test Necessary to Determine Air Volumes

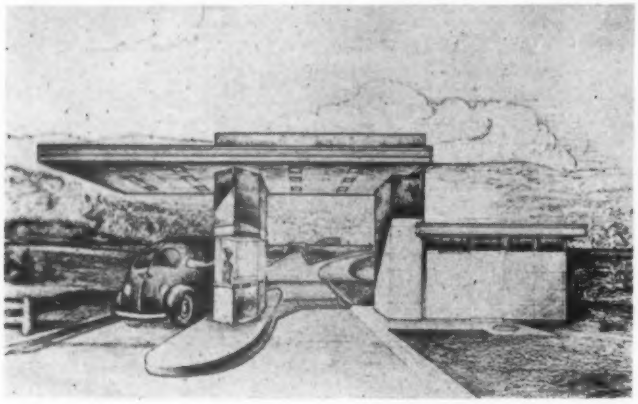
delta operation is possible in emergency and space is also provided in each substation for a fourth (spare) transformer should that be considered advisable at a later date to insure uninterrupted power supply from the substation. The sources of primary power together with power lines between tunnels were developed having in mind a maximum of reliability in source and distribution.

Distribution from the substations will be controlled by the supervisor and the fan motors will be provided with 440 volt power with the exception of motors 100 horsepower and over which will be 2,300 volts. Since the substation is located for each tunnel at one portal, distribution to the remote portal buildings is provided through duct lines in the tunnel at 2,300 volts.

The duct lines in addition to carrying the tunnel lighting lines will also carry a 30 conductor cable for each tunnel for signals, C O recording transmission, remote control of equipment, etc. There will also be provided a telephone system local to each tunnel. This will provide communication between the portal buildings for operation purposes and a line will be provided for tunnel service in calling tunnel attendants and also for calling from drivers to the supervisor should this be necessary. The remote tunnel portal ventilation buildings will have transformers for stepping down 2,300 volts to 440 volts as required, these transformers having taps for 220/110 volt lighting service.

There are ten interchanges at which points ticket offices will be located providing access to and from the Turnpike. Each ticket office will be provided with facilities for the operators and a gasoline motor driven generator set for emergency use in case of power failure. The ticket offices will be lighted by means of fluorescent lighting and incandescent lighting. The maintenance buildings will be provided with facilities same as provided for the tunnel portal buildings.

(*Continued from page* 54)



Architect's Drawing of Toll Booth

roofs or canopies so that attendants will be shielded from rainfall at all times while transacting business with motorists.

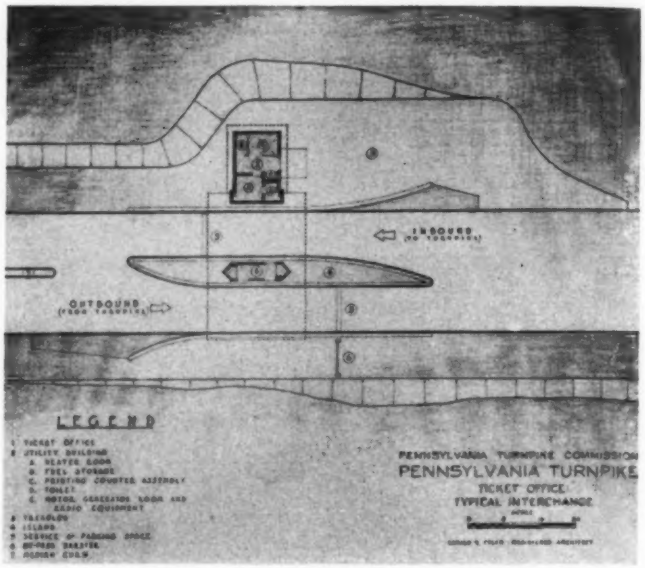
Each utility building will have the following equipment; printing counter assembly, heating plant, toilet and lavatory for use of the attendant only, lockers for attendants, 5-kilowatt electric generator for emergency electrical service, space for radio equipment which will possibly be provided at some future time.

In each lane opposite the booths, treadles are to be provided over which the wheels of all vehicles must pass. These treadles register the number of axles and are connected with devices known as printing counter assemblies. These counter assemblies record on tapes the number of vehicles passing the ticket offices. The counter assemblies will be housed in the utility buildings and are locked so that access to them can only be had by inspectors or auditors. Attendants have no way of changing the records which are automatically printed on tapes by the counter assemblies.

Each ticket booth is heated by a unit in the ceiling which in turn is connected through the overhead canopy to the small heating plant in the utility building. The plan of each ticket booth has been carefuly worked out so that a minimum of steps and motions is required by the attendants.

The side walls of the booths will be made of heat absorbing glass. The glass will be set at angles toward incoming and outgoing traffic so that reflections are eliminated. In fact all glass is designed to be placed so that 100 per cent vision can be maintained for the attendant to view approaching traffic. In one end of each booth enclosure is a steel counter with locker underneath. On top of this counter various recesses will be installed to fit the different sizes of tickets which are to be used. In the opposite end of each booth enclosure another counter is to be installed with a money slot on top. After fares are placed in these slots they drop down through a chute in which an angle is provided and fall into a deposit locker. This locker is made of quarter inch open hearth steel, reinforced by heavy steel angles and encased in 4 in. thick reinforced concrete. The lockers could only be removed by demolishing the entire ticket office with explosives. Attendants have no access to the lockers, since money may only be removed from them by opening the bank vault-type doors, and combinations to these are known only to inspectors or auditors.

The architectural design is functional, though it has not been forced or exaggerated for the mere purpose of producing something "different". No unnecessary ornament of any kind has been provided. The outside walls are porcelain enamel on 16 gauge steel plates or sheets. These sheets have 1 in. insulation back of them and are removable. They are supported on a steel superstructure and the interiors of the utility buildings are made of 18



Plan Layout of Toll Booth Arrangement

gauge sheet steel. Interior and exterior trim of ticket booths and canopies will be aluminum. Steel projected sash is provided for utility buildings.

In considering a color scheme for the ticket offices, the Commission wished to avoid gaudy colors and to keep the buildings dignified. Since the Turnpike traverses a region where nature has provided bold colors which predominate during most of the year, it was felt that the color scheme should be in keeping with the natural settings of the buildings. Neutral or dead colors would have been inappropriate. Light shades would have shown dirt. For these reasons blue surfaces relieved by horizontal bands of ivory and aluminum around the canopies were chosen. This color scheme will of course depend for further effect upon the judicious planting of low evergreens around the bases of the buildings.

GRADING, PAVING—NAVAL AIR BASES

A large amount of grading and runway paving will be required in connection with the expansion of existing naval air bases and the establishment of new bases provided for under the $124,132,000 appropriation for the naval air force. The sums are as follows:

Quonset Point, Rhode Island	$24,204,000
Quantico, Virginia	2,326,000
Norfolk, Virginia	13,246,000
Guantanamo, Cuba	2,888,000
St. Thomas, Virgin Islands	1,510,000
San Juan, Porto Rico	2,300,000
Coco Solo, Canal Zone	12,690,000
Corpus Christi, Texas	25,000,000
San Diego, California	5,637,000
Alameda, California	6,861,000
Tongue Point, Oregon	2,000,000
Seattle, Washington	4,670,000
Kodiak, Alaska	2,112,000
Unalaska, Alaska	2,963,000
Midway Island	1,870,000
Wake Island	5,582,000
Johnson Island	460 000
Canton Island	1,500,000
Kaneohe Bay, Hawaii	578,000
Pearl Harbor, Hawaii	5,807,000

LANDSCAPING PLANS

Trees, Shrubs and Plants to Hide Scars of Construction

By RALPH W. STEWART
Landscape Architect,
Pennsylvania Turnpike Commission

FROM the beginning, the members of the Turnpike commission fully realized the value of proper landscape treatment. Besides the necessity for eliminating the scars of construction, they desired to plan and plant to produce a harmonious aesthetic effect which would convert the entire right-of-way into a natural treatment of typical Pennsylvania scenery. Such a treatment would be a forward step from the landscape treatment of the Pennsylvania highways of the past but would not be as elaborate as city parkways or boulevards.

One of the first problems of landscaping work on the Turnpike will be the conversion of the farm and forest lands of the right-of-way into a more aesthetic condition. This will involve the removal of dead and defective trees as well as large dead branches which might be blown onto the highway by heavy winds; the removal and burning of stumps, brush, logs, farm crop stubble, obsolete fences and abandoned farm structures; obliteration of abandoned or relocated township roads and farm lanes; removal of rubbish dumps; opening of clogged streams and protecting the banks of streams and ditches from erosion; and the grading of certain rough areas.

Clay surfaced areas will be resurfaced with a layer of top soil to encourage a vegetative covering. Waste piles will be covered with fast growing vines or screened from view. The regrading of some small areas may be necessary to soften the sharp edges of cuts to produce a more natural effect.

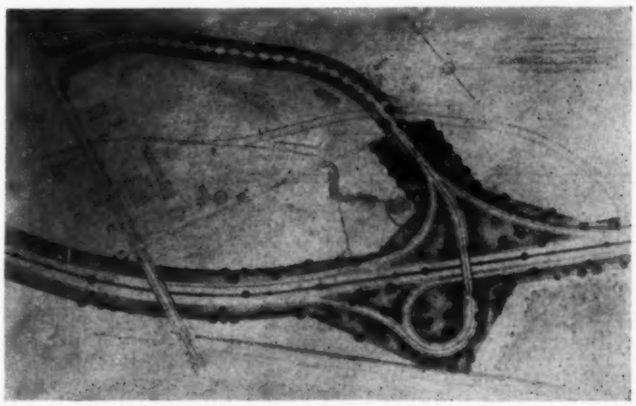
Although the term landscape architecture usually implies luxury and beautification to the average individual, the profession also covers the practical side of safety and protection, particularly on a project such as this. Planting, therefore, will be used for erosion control, snow fences, and to screen out sun and automobile headlamp light on curves.

The cuts and fills will be planted with trees, shrubs, or vines which have a vigorous root system and fast growing tops. These plants will be planted in pockets of topsoil augmented by organic fertilizer to assure an immediate cover for the exposed surfaces. Although erosion will be kept to a minimum due to the diversion ditches as well as the surface drains of the highway, the planting of these banks will help to prevent erosion, serve to hold in check any loose rock which might roll down the slopes, and help to cover the scars with a more pleasing effect of vegetation planted in a natural and informal composition.

Due to the ample width of the right-of-way, it will be possible to have permanent snow fences in the form of group plantings of evergreens and densely branched shrubbery will serve as wind breaks in the winter and have a pleasing vegetative effect in the summer.

Although no definite decision has been reached as to the treatment of the ten foot medial strip, consideration is being given to planting this strip with low growing grasses or other ground cover. Such a cover would be easily maintained and would help to clearly define the traffic lanes as well as eliminate dust. On the curves, at the interchanges, and other points where headlamp light might blind oncoming traffic, planting is planned in this center strip to screen out the glare. The planting will be arranged so that it will not serve as a snow fence nor as a wind break. Scattered trees will also screen out early morning or late afternoon sun.

Besides these practical features, the landscape program calls for the beautification of the entire right-of-way.



Architect's Layout of Somerset Interchange Landscaping

The interchanges will afford an opportunity for the use of formal design in the area adjacent to the ticket houses. Here seasonal displays of bulbs, annuals and perennials will add color and interest. Trees, shrubs, and evergreens together with well kept lawn areas will combine to make the first impression of the Turnpike a pleasant one.

The overhead structures and tunnel approaches will be planted to soften the architectural lines of the structures and blend them with the surrounding country. The maintenance buildings will have planting to screen from view the areas used for storage of materials and equipment as well as for the general beautification of these buildings. The gasoline stations and restaurants which are being built and operated by the gasoline companies will also be landscaped by them in a formal and attractive manner.

At several points along the road, sites have been selected for the construction of rustic overlook structures where the motorist may stop to enjoy the view and rest his eyes from driving. These spots will have accelerating and decelerating lanes and will be separated from the highway by planting to prevent their being a hazard to traffic.

It is also proposed to create large group planting for seasonal attractions such as dogwood, red bud, evergreen plantation, rhododendron, evergreen and flowering trees in their native sections as well as to plan the entire planting program for spring and fall color effect. All plantings will be either native or naturalized.

Preliminary plans and estimates have been submitted and tentative arrangements initiated for the execution of the program. It is expected that several thousand men for a year or more will be employed on this work. Approximately 100,000 trees, 1,250,000 shrubs, 1,750,000 vines, 50,000 perennials, 40,000 annuals, 100,000 bulbs, and several thousand reforestation trees will be required. In addition, 20 tons of grass seed and 1,000 tons of fertilizer will be used.

The following table shows the general scheme for the planting of the various sections of the highway for seasonal effect:

County	*Spring*	*Summer*	*Fall*
Cumberland	Apple, Cherry and Peach trees—ten miles — intermittently. Bulbs and perennials at Middlesex and Carlisle interchanges.	Climbing honeysuckle on banks of cuts and fills. Annuals and perennials at Middlesex and Carlisle interchanges.	Trees for fall color—through entire county. Box Elder, Norway Maple, Sweet Gum, Tulip Tree, Oriental Plane, Weeping Willows.
Franklin	Hemlock and White Birch — five miles. Bulbs and perennials at Blue Mt. and Willow Hill interchanges.	Hemlock and White Birch. Annuals and perennials at Blue Mt. and Willow Hill interchanges.	Trees for fall color through entire county. Red Maple, Weeping Willow. Tulip Tree—Sumac—Oriental Plane—Sweet Gum.
Huntingdon and Fulton	Red Bud—4 miles (between Ray's Hill and Sideling Hill tunnels). Bulbs and perennials at Ft. Littleton interchange.	Pine—5.5 miles intermittently. Annuals and perennials at Ft. Littleton interchange.	Trees for fall color—through entire county — Sumac, Sassifrass, Red Birch, Wild Cherry, Golden Willow, White Oak, Sugar Maple.
Bedford	Flowering Dogwood — 7.5 miles. Bulbs and perennials at Breezewood and Bedford interchanges.	Rhododendron—6.5 miles. Larch—4 miles. Annuals and perennials at Breezewood and Bedford interchanges.	Trees for fall color—through entire county—Sumac, Yellow Birch, Weeping Willow, Tulip Tree, Oriental Plane, Red Maple, Sweet Gum. Huckleberry on low banks in wooded sections.
Somerset	Laurel and Azalea—10 miles. Bulbs and perennials at Somerset interchange.	Rhododendron—10 miles. Larch 3.5 miles. Annuals and perennials at Somerset interchange.	Trees for fall color—through entire county. Sugar Maple, Red Maple, Sassafrass, White Oak, Red Birch, Mt. Ash. Huckleberry on low banks in wooded sections.
Westmoreland	Hawthorne and Flowering Crab Apple—5.5 miles. Bulbs and perennials at Donegal, New Stanton and Irwin interchanges.	Climbing roses on banks — 6.0 miles. Annuals and perennials at Donegal, New Stanton and Irwin interchanges.	Trees for fall color—through entire county—Sumac, Box Elder, Red Birch, Norway Maple, Choke Cherry.

CONCRETE DESIGN

(*Continued from page* 57)

by 40 in. test beams for flexual strength are made for each 10,000 square yards of pavement placed. Test cylinders are laboratory cured and tested and are intended to represent quality of concrete as deposited on the subgrade. Beams are cured at the site of the work under the same conditions as the pavement which they represent and are broken at appropriate ages. Insufficient test data are available at this time to warrant a tabulation of results.

It is contemplated that cores drilled from the pavement, intended primarily for determining pavement depth, will furnish additional information on concrete quality upon completion of the work.

Fig. 2—Batching Plant Setup on Union Paving Co. Job, Contract No. 56. The Plant is Set for 27E Batches

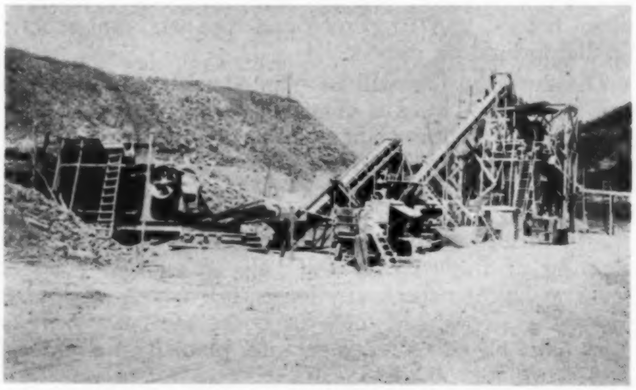


Fig. 3—Portable Crushing Plant Setup for Producing About 100,000 Cu. Yds. of Coarse Aggregates for the States Engineering Co. Job

Turnpike Accident Prevention

By T. W. OSGOOD

Chief Safety Engineer,
Pennsylvania Turnpike Commission

SAFETY has been a matter of great concern to the members of the Pennsylvania Turnpike Commission and, throughout the period of construction, they have insisted upon full cooperation from everyone concerned in the endeavor to safeguard all persons employed on the Turnpike. In this connection, the commission caused to be written into the contract specifications, comprehensive safety and health provisions, including by reference, all pertinent regulations of the Pennsylvania Department of Labor and Industry and, the "Manual of Accident Prevention in Construction," prepared and published by the Associated General Contractors of America, Inc.

The elimination of hazards has been well served by generally new and good mechanical and electrical machinery and other plant equipment. These have been kept in a good state of repair and hazardous points are guarded so far as practical.

Explosives—It is estimated that about 6 million pounds of explosives will be consumed on the project and, being a potential catastrophe hazard, every possible safeguard is thrown around the storage, transportation and use of explosives. Fire-proof, bullet-proof, theft-proof, and well ventilated Class "A" magazines are provided for the separate storage of dynamite and blasting caps. These magazines are located on the surface at least 100 ft. apart and at safe distances from construction operations, buildings, highways and railroads. Class "B" magazines for the separate storage of dynamite and primers in quantities not exceeding 200 pounds are placed on the surface not less than 100 ft. apart and at safe distances as indicated for first class magazines.

The sign, "MAGAZINE — EXPLOSIVES — DANGEROUS" is posted conspicuously near magazines, which are kept locked whenever unattended by authorized persons.

Explosives are transported to the contractors magazines in enclosed automobile trucks equipped with warning signs and red flags displayed at the front and rear. The safe operation of trucks is governed by appropriate rules. Dynamite and primers in suitable boxes are transported from magazines to tunnel headings in separate powder cars, or trucks.

Smoking and open flames are prohibited at any place where explosives are stored, handled or used.

Blasting Equipment—Electric detonation, employing 220 or 440 volt alternating current, is used exclusively for firing blasts at tunnel headings. Blasting lines extend from blasting switch to heading and consist of No. 8 AWG single conductor rubber covered copper wire, installed on insulators on the side of the tunnel opposite all other electric circuits and pipe lines, wires are spaced at least 5 in. apart and are placed not less than 8 ft. above the tunnel floor; splices are staggered and provided with insulation equal to that of the wire. An externally operable fused switch is installed at the transformer to protect the blasting circuit.

The blasting switch is an externally operable, double-pole, double-throw type and is normally held in the "off" position by a spring. In the "off" position the two wires of the circuit are short-circuited but not grounded. The line clips are equipped with arc quenchers. The switch box cover cannot be removed when the switch handle is locked in the "off" position, and the handle can be locked in the "off" position only. The blasting switch, when installed underground, is located not less than 1,000 ft. or more than 3,000 ft. from the tunnel face.

A two-conductor No. 8 AWG type "S" portable cord is provided to make connection between the switch at the source of blasting current, and the blasting switch.

The safety switch is located not less than 500 ft. from the tunnel face and is of the same type as the blasting switch but is not equipped with a spring. In the "off" position this switch provides a break in the blasting line, and the wires leading to the face are short-circuited but not grounded.

Leading wires are No. 16 or 18 AWG single conductor blasting wire. Bus wires are not smaller than No. 16 AWG bare copper wire.

Tunnel Blasting Rules—Before explosives are delivered to the face, all electric circuits are removed at least 75 ft. from the face and are disconnected from the source of electric energy. These circuits remain at this location and are not energized until after loading operations are completed and the blast has been fired. During loading and connecting a round, the heading is illuminated by electric flood lights located not less than 75 ft. from the face.

All switches in the blasting line, and the connecting cord, are kept locked in the "off" position except at the time of firing a blast.

Blasting keys are kept on the person of the shift boss who does all of the shot-firing. Electric blasting caps are tested with a galvanometer approved for the purpose.

Before connecting leading wires to the blasting line, the latter is tested with a galvanometer approved for the purpose, to make certain that the line is not energized. Cap-wires are short-circuited until connected to the bus-wires which are short-circuited until connected to the leading-wires; and the free ends of leading-wires are shorted up to the time they are connected to the blasting line. Bus-wires and leading-wires shall be suspended on wooden supports and shall not contact any other object or the ground.

During loading and connecting a round, the number of men at the heading are kept at a minimum, all others retire to the blasting switch.

Electric blasting or preparations for electric blasting are not done during electric storms.

Wooden tamping sticks only are used and they are sawed off at the end as conditions warrant.

On the surface work, provisions for safe storage, handling and use of explosives, similar to those for tunnel work, are made operative wherever applicable and, alternate regulations are instituted as conditions warrant.

Miscellaneous—All workers and other persons, while in a tunnel, are required to wear protective hard hats.

The use of goggles, respirators, life belts, hard-toe shoes and other similar protective devices, have contributed to the safety of the workmen.

SOME PERSONALITIES

On the Engineering Work of the Pennsylvania Turnpike

A project the size of the Pennsylvania Turnpike requires the hard hitting efforts of a large corps of engineers. The editors realize the impossibility of giving a short experience sketch to each one and hope that by this means that recognition will reach them through their executive officers.

W. A. Jones

Mr. Walter A. Jones, Chairman of the Pennsylvania Turnpike Commission, is a graduate of Ohio Wesleyan University. Some years later he became President of its Board of Trustees. He has been in the glass, coal and oil business since 1910. He was appointed by President Roosevelt to serve on the Sub-Divisional Coal Code Authority, and was also a member from Pennsylvania to the Interstate Oil Compact Commission.

He is President of the Good Neighbor League in the United States and is one of the 35 underwriters of the Roosevelt Memorial Library at Hyde Park.

He is a 32nd degree Mason and a life member of both the Shrine and the Consistory. He is a member of the Sons of the Revolution; a former member of the Methodist Board of Foreign Missions and is one of the members of the Board of Trustees, American University.

Wm. T. Staats

Mr. William T. Staats, Assistant to the Chairman, Pennsylvania Turnpike Commission, for many years after graduation from Lehigh University was employed in the general contracting and heavy construction industry. Besides tunnel work in Canada his experience embraces highway construction in New York, New Jersey, Delaware, Maryland, West Virginia, and Pennsylvania. Prior to joining the Turnpike staff he acted as Chief Resident Engineer of Western Pennsylvania for the P. W. A. with which he served for five years.

In his present capacity it is his duty to expedite and coordinate the activities of field and office work in an executive administrative capacity. He is a member of the National Society of Professional Engineers and the Society of Military Engineers.

J. F. Murphy

Mr. James F. Murphy, Project Engineer of Turnpike for P. W. A., attended both Columbia and Wisconsin Universities. His early employment was successively with the Chicago and Northwestern Railroad, Westinghouse Kerr & Co., the New York Telephone Co. and then for ten years with the Board of Water Supply, New York City on the Hoboken masonry dam and earth dikes. Later was Chief, Division of Public Assembly, New York City; Superintendent, constructing water filtration plant at Accotnik, Va.; Assistant Superintendent for G. A. Faller Co. on air nitrate plant at Ancor, Ohio; Supt. and Chf. Engr. for Langthorn Co. on eight miles of concrete pavement; then Vice-President of Beaver Engineering and Construction Co. From President of J. F. Murphy Construction Company, building rectifier stations, he entered the service of the Federal Government in October, 1933, and has since been so connected except for a year with the construction of the World's Fair as Assistant to Chief Engineer.

S. W. Marshall

Samuel W. Marshall, Chief Engineer of the Pennsylvania Turnpike Commission, heads the engineering organization that is building Pennsylvania's great, new superhighway. Graduate of the University of Pennsylvania, 1915.

His first job was with United Gas Improvement Corporation at Oshkosh, Wisconsin, and he became assistant superintendent. Later he became assistant to the engineer of the Fulton County Gas and Electric Company at Gloversville, New York.

During the World War he went overseas as a captain with the 28th Infantry, 1st Division; was awarded the French Croix de Guerre and the American Silver Star. After returning from overseas Mr. Marshall became associated with Ballinger and Perrot, a well-known firm of architects and engineers located in Philadelphia. Later, he established himself in his own private engineering practice in Philadelphia. He was appointed Chief Engineer of the Pennsylvania Department of Highways in 1937. While serving here he was appointed Chief Engineer of the Turnpike Commission.

C. M. Noble

Mr. Charles M. Noble, M. Am. Soc. C. E., Special Highway Engineer, Pennsylvania Turnpike Commission, on design and construction, has been engaged in engineering for the past 25 years in various parts of the East and during the war served overseas in the Subchaser Service of the U. S. Naval Reserve Force. After years of highway work, Mr. Noble became connected with the Port of New York Authority, where he remained until September, 1938.

Mr. Noble is the author of various works on express highway design and is visiting lecturer on this subject before the graduate school at Yale University. In 1938 Mr. Noble was awarded the Clemens Herschel Prize of the Boston Society of Civil Engineers. In January,

1939, he was awarded the Arthur M. Wellington Prize for his paper, "The Modern Express Highway."

R. M. Merriman

Mr. Richard M. Merriman, Chief Tunnel Engineer, graduated from Lehigh University with the degree of Civil Engineer, 1906. His professional experience has taken him to such places as Canada, Puerto Rico, South America, France, Italy, Greece and many states of the United States. He has specialized in tunnel work for the past 17 years, during which time he has had charge of the construction of five miles of tunnels in Kansas City, Missouri, eleven miles in Greece, 34 miles on the Colorado Aqueduct in California, two miles in Wyoming and seven miles for the Pennsylvania Turnpike Commission. He has also, in a consulting capacity, reported on a large number of tunnels under construction and to be constructed in all parts of the United States.

R. B. Stone

Mr. Roger B. Stone, Chief Construction Engineer, studied Civil Engineering at Massachusetts Institute of Technology, class of 1912.

Mr. Stone has had twenty-eight years of general engineering experience including fifteen years with several railroads. He served the City of Philadelphia for a period of four years as Senior Engineer on the Broad Street Subway. He spent three years as Resident Engineer with the Pittsburgh and West Virginia Railroad on their 30 mile extension from Pittsburgh to Connellsville.

Mr. Stone was in charge of the preliminary engineering, surveys, and studies of the Turnpike. His present activities envelop him in the construction phases.

F. S. Poorman

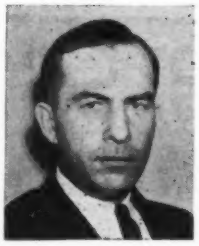
Mr. F. S. Poorman, Assistant Chief Engineer, graduated at Dennison University, Granville, Ohio, class of 1923.

Formerly with the Pennsylvania Department of Highways, his assignments involved substantially all field and central office design and construction. Special assignments included formulation and supervision of the operation of a state-wide highway W. P. A. program, representative on the Governor's Emergency Flood Committee during the flood of 1936.

He was transferred to the commission in August, 1938, as Engineer of Design and Specifications. In April, 1939, he was appointed Assistant Chief Engineer.

E. J. Kinney

Mr. Edwin J. Kinney, Engineer of Design and Specifications, began his highway engineering experience in April, 1919, with the Pennsylvania Department of Highways as a draftsman. He served in numerous office and field capacities and was appointed Assistant Division Engineer in May, 1923. In July, 1933, was appointed a District Engineer, continuing in the employ of the department until February, 1939. Mr. Kinney entered the employ of the Pennsylvania Turnpike Commission in February, 1939.



Ivan L. Tyler

Mr. Ivan L. Tyler, Concrete and Materials Engineer, attended California Institute of Technology and was a graduate at Massachusetts Institute of Technology, 1923.

Experience includes seven years with the Southern California Edison Company on water power construction, two years with Phoenix Utility Company on special problems in concrete, two years with Pasadena (California) Water Department as engineer on concrete construction, five years with the Tennessee Valley Authority as Materials Engineer.

He is a member of the American Society of Civil Engineers and the American Concrete Institute.

W. F. Gould

Mr. Wm. F. Gould, C. E., Central Office Engineer—Tunnels, attended Purdue University, 1918-19, University of Wisconsin, 1919-20, graduated Evansville College, Evansville, Indiana, 1925, degree of Civil Engineer. He became Office Engineer and subsequently President of the consulting engineering firm in Jacksonville, Florida. Member of faculty Evansville College, Evansville, Indiana, in Civil Engineering subjects. As Administrative Assistant Engineer, The Port of New York Authority, he was in charge of construction of Riverside Drive connections of George Washington Bridge, was transferred to Assistant Chief Engineer's Office in charge of contracts and specifications for Lincoln Tunnel and George Washington Bridge. He handles general administrative engineering work of the Tunnel Division of the Turnpike and is Designing Engineer in charge of contracts and specifications for tunnel construction under the Chief Tunnel Engineer and the Chief Engineer.

R. F. Graef

Mr. Richard F. Graef, Chief of Bridges, graduated from school of Civil Engineering, Cornell University.

After short time with a reinforcing bar company, went to Reading as Civil Engineer on extensive water works improvement project. In 1928 he joined staff of Whitman, Requardt & Smith, Consulting Engineers on Albany, New York, water works project. Left to go with United Engineers & Constructors, Inc. Returned to Reading in 1932 as Structural Engineer, later Asst. to Chief Engineer.

Upon completion of this project, became a Bridge Designer in Bridge Division of Pennsylvania Department of Highways. Left to become a Structural Engineer with H. K. Ferguson Company, from which position came to Turnpike in present capacity.

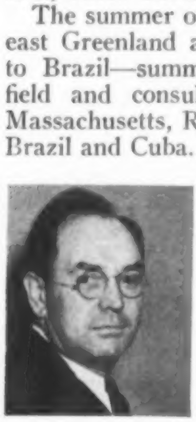
A. B. Cleaves

Mr. Arthur B. Cleaves, Chief Geologist, attended Brown University, awarded Ph.B. in 1927, A.M. in 1929, awarded M.A. at University of Toronto, 1930, then M.A. at Harvard University, 1932, and Ph.D. in 1933.

His experience includes, Lafayette College — Instructor, Paleontology, Physical and Historical Geology, Instructor in Geography and

Physiography, 1933-1936; Pennsylvania Geological Survey, Junior Geologist; Pennsylvania Turnpike Commission, Chief Geologist, 1938.

The summer of 1933 he was on expedition to Northeast Greenland as Chief Geologist, then an expedition to Brazil—summer of 1934, as Chief Geologist. His field and consulting work covers New Hampshire, Massachusetts, Rhode Island, Pennsylvania, Greenland, Brazil and Cuba.


E. O. Marty

Mr. Edgar O. Marty was graduated from the University of Michigan with a degree of Bachelor of Science in Mechanical Engineering in 1910, Masters Degree conferred in 1932 from same university.

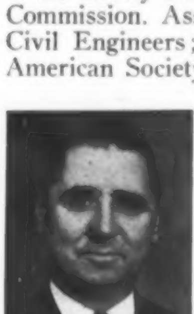
For approximately ten years following his graduation, he was associated with Frank F. VanTuyl in Detroit, Michigan, Consulting Mechanical and Electrical Engineer. In 1924 Mr. Marty entered the anthracite mining industry. In this work he carried out the development and operation of two properties, the larger one of which a 2,000 acre tract of anthracite coal land, entailed the construction of a coal washing plant, the installation of substations, power distribution, mine ventilation, transportation, refuse disposal equipment, and mine development.

Since June 6, 1938, he has been employed by the Pennsylvania Turnpike Commission and is at present Chief Mechanical and Electrical Engineer.


T. W. Osgood

Mr. T. W. Osgood, Chief Safety Engineer, was educated at North Dakota State College and Massachusetts Institute of Technology. His more important experience includes Assistant to Resident Engineer, Colorado Fuel and Iron Company, Canyon City, Colorado; Assistant to Chief Engineer, Oregon Land and Water Company, West Umatilla Irrigation Project; City Engineer, Medford, Oregon.

After 15 years of private engineering practice, he went with the Industrial Accident Commission for State of California, 14 years as Assistant Chief of the Department of Industrial Accident Prevention. From 1933 to 1938 he was Chief Safety Engineer for The Metropolitan Water District of Southern California, on the Colorado River Aqueduct. Since May, 1939, he has been Chief Safety Engineer for the Pennsylvania Turnpike Commission. Associate Member, American Society of Civil Engineers; Registered Civil Engineer; Member, American Society of Safety Engineers.


G. R. Tyler

Mr. Gerald R. Tyler, Chief Architect, graduated in Architectural Engineering from Clemson College. Three years extension work in Architecture at Columbia University. Two years Infantry Officer with 1st Division, A.E.F. Awarded Crois de Guerre and other decorations. Several years as designer and draftsman for various New York City architects. Ten years independent practice as architect in Florida and Philadelphia. Member American Institute of Architects and Pennsylvania Association of Architects. Formerly Chief Architect and Eqpt. Engr., Penn. Department of Highways.

The architectural unit turned out plans and specifications on all tunnel ventilation buildings, ticket offices, and maintenance buildings.


R. W. Stewart

Mr. Ralph W. Stewart, Landscape Architect, Pennsylvania Turnpike Commission, graduated from Cornell University, with degree of Bachelor of Landscape Architecture. He served in World War, following which he practiced landscape architecture in Buffalo, St. Petersburg, Detroit, and Pittsburgh.

Designer of a Soldiers and Sailors Memorial Park for Allegheny County, Pennsylvania. Landscape Architect with the National Park Service. He is now in charge of the landscape treatment of the Turnpike right-of-way as well as general beautification of the interchanges, tunnel approaches, overhead structures, maintenance buildings and roadside areas.


J. D. Paul

Mr. John D. Paul, Assistant to Chief Construction Engineer, attended the University of Pennsylvania.

He enlisted in U. S. Army Engineers and served overseas with 78th Division. His first engineering position was draftsman with C. F. Class, Concrete Engineer, Harrisburg.

Following discharge from Army in 1919 became Inspector with Pennsylvania Department of Highways. Promoted through engineering grades of Chief Inspector, Asst. Construction Engineer, Asst. District Engineer, District Office Engineer. Transferred early in 1937 to the "South Penn Survey" as Plans Engineer. Transferred to Pennsylvania Turnpike Commission in November, 1938, as Construction Engineer, continuing in capacity of Asst. to Chief Construction Engineer.

Registered Professional Engineer in Pennsylvania. Member Pennsylvania Society Registered Professional Engineers.

In addition to the personnel above, key men responsible for the preparation of plans, specifications, the advertising of plans and receipt of bids, field construction, and tunnels have played a major part in making possible the exceptional progress of the Turnpike work.

Those to whom recognition should be given include: F. J. Gehrlein, Assistant Engineer of Design and Specifications; D. D. Williams, Central Office Plans Engineer; J. J. Donohue, Central Office Assistant Plans Engineer; H. E. Kunsch, Assistant Bridge Engineer; and District Plans Engineers C. L. Clark, E. E. Trego, J. G. Wolfe and F. D. Franz.

Frank C. Sellnow, Resident Engineer in charge of the construction of Kittatinny Mountain tunnel and Blue Mountain tunnel and their approaches. Kenneth C. Bellows, Resident Engineer in charge of the construction of Tuscarora Mountain tunnel and its approaches. Thomas M. Roach was until recently Resident Engineer on Sideling Hill tunnel and its approaches. Following his resignation, Assistant Resident Engineer John W. Hadesty took over his work. Edward A. May, Resident Engineer in charge of construction of Rays Hill tunnel and its approaches. Cass A. Budnik, Resident Engineer in charge of the construction on Allegheny Mountain tunnel and its approaches. Cass A .Budnik is now Resident Engineer in charge of construction on Laurel Hill tunnel and its approaches, succeeding E. R. Dinkle, deceased.

METHOD OF INSTALLING 15-FT. MULTIPLATE CULVERT


Engineer Bonesteele (Left) and Supt. Mattson

By S. C. BONESTEELE
Resident Engineer,
Montana State Highway Department

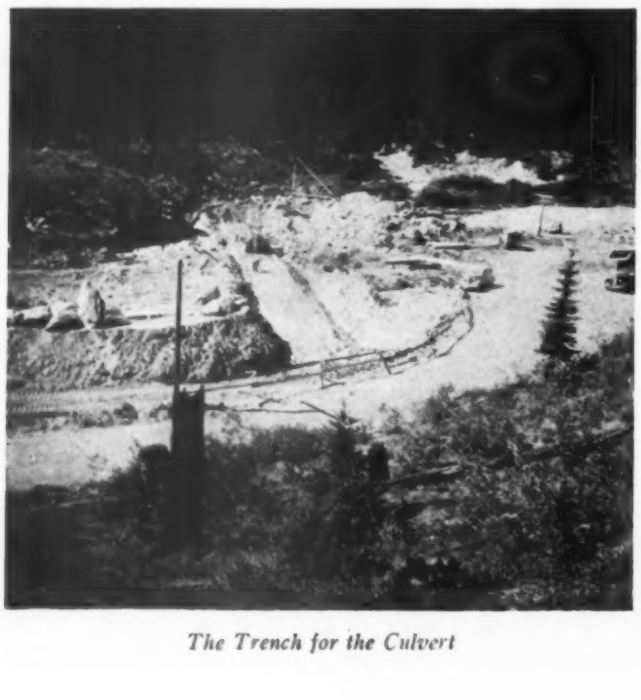
RECONSTRUCTION during 1939 of a portion of U. S. Route 10 in Montana through Lookout Pass called for the construction of two large culverts, one under a high fill. This project, Federal-Aid Project 183 A (2) and C (1), extended from the Montana-Idaho state line east for a distance of 6½ miles. Just the heavy grading and drainage structures are involved; surfacing is scheduled for a later contract.

The two large drainage openings were located about 2½ miles from the state boundary. Armco multi plate pipes were used. The 180-in. diameter pipe was to be under a high fill (45-ft. of cover), and the 120-in. pipe was under a minimum fill. For these locations a flexible structure was considered desirable and proved to be economical to construct.

The 180-in. diameter structure is 200 ft. long at the center line, but because the ends were cut on a bevel or slope of 1½:1, the top length was 178½ ft., the bottom 222½ ft. Twelve plates were required to complete the circumference of the pipe. The bottom three plates throughout the entire length were of No. 1 gage Armco ingot iron. Except for the center 70 ft. of the pipe which was No. 1 gage, the remainder of the pipe was of No. 3 gage plates.

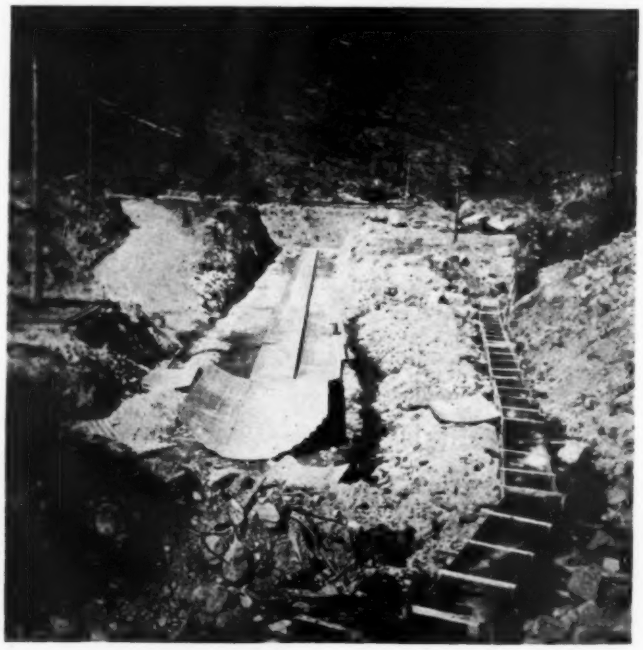
Plates for the entire structure were punched for 6 bolts per foot instead of the conventional four in order to provide increased strength under the heavy fill.

For the 120-in. multiplate pipe, the length on the center line is 65 ft., and the ends beveled 1½:1. The bottom 3 plates for the entire invert are No. 1 gage, whereas the remainder are No. 3 gage. The heavier gage provides increased durability in the bottom where the wear is hardest.


The Trench for the Culvert

Construction Procedure 180-In. Pipe

When the plates were unloaded from the cars, they were stacked in piles of about 20 plates each and strung along the side of the trench so that a minimum number of them would have to be handled more than once. Before starting the erection, it was thought advisable to build a rig or derrick that could be used to place a number of plates from one set-up. Had the culvert been of smaller diameter and shorter length, a simple tripod or A-frame could have been used for erection; but a tripod with legs long enough to clear a 15-ft. diameter pipe would be quite hard to handle and too much time would have been lost in moving it for a few plates.


Base Plate and Flume for Temporarily Carrying the Stream

The rig constructed for this job consisted of a 25-ft. timber mast on a cast iron plate resting on a log frame. This rig with a swing of 360 degrees served very well. It was quite stable even when unguyed, and it was readily moved by means of 4-in. log rollers under the base.

Erection was started in the usual manner by placing all the base plates first, starting at the downstream end

(*Continued on page* 92)

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ An argument developed between two Texas highway patrolmen as to whether or not a motorist would stop and remove an obstruction on a traveled roadway. So they placed a large cardboard carton on a paved, fairly well traveled road with five $1.00 bills under it. During a long period of waiting only one vehicle stopped. It was a maintenance truck for the state highway department. The officers agreed that this didn't count so put the empty carton and money back again. Finally, after a long wait they got tired—the argument settled, repocketed their money and left. Now if you see an obstruction in the roadway tomorrow. . . .

• •

¶ From one of our long-horn Texas friends we got the sketch below and the one on the opposite page made by J. T. H. of Beaumont. Thanks M. B. H. for the "cute" pictures (at least that's what the girls call them). Sorry I felt I had to revise one of them slightly.

You know, M. B. H., the picture with the seal coat is, in a way, an indirect criticism of you Texans. I note that the girl is looking south to the wild waves of the Gulf for a bit of romance or excitement. Up in Nevada or Wyoming she wouldn't need the binoculars. If you don't believe me ask Allen or Seifried.

RESHAPING FLEXIBLE BASE

• •

¶ Here's a new type of grade crossing signal device to me. This "magnetic wigwag flagman" with vertical stop sign of red glass was installed on the Union Pacific Railroad at

Redwood Road Crossing, Salt Lake City, Utah, as part of the federal grade crossing program. The swinging wigwag banner of black and white design replaces old red banners.

¶ WHY ARE FIRE TRUCKS RED?

Since two people have four feet, four feet is a yard and one third, one third of a yard is one foot, and one foot is a ruler, Queen Mary was a ruler and she sailed on the seas, and since the seas have fishes, the fishes have fins, the Finns fought the Russians, and the Russians are red. Aren't fire trucks always rushin'?

• •

¶ Ladies and Gemmun! I give you that genial gentleman, the jovial, jocular jitterbug, Master of Ceremonies Don Lee. Here he unravels the skein

of his previous evening's efforts in creating cautious comedy. Why does that Texas crowd always pick on such a little guy.

• •

¶ Let's not disturb Maryland roads any more than absolutely necessary. After all, they affford us an opportunity to say to our children as we drive over them, "Now you can see the way that grandfather had to travel." There's a certain different sort of feeling in prodding around through antiques.

• •

¶ On my way to El Paso from Phoenix I traveled a new wide highway south of Las Cruces, New Mexico. That road is badly in need of a center stripe.

¶ Visiting Stanley Abel's office, he's a County Supervisor, Kern County, Calif., you know, I passed an open doorway. The first thing that entered

my mind when I saw the layout of the little room was: This must be Stanley's library. Note the engineering magazines right handy—for reading, of course.

• •

¶ In the cattle country dipping vats are constructed for the purpose of keeping cattle tick free. In Texas, we have a dipping vat for cars. It is the only one which I know to be in existence. This vat is located on State Route 4 just east of Brownsville, and was constructed by Cameron County in connection with the construction of the highway to Boca Chica several years ago.

Boca Chica is on the Gulf of Mexico, and along the shore line there is a very nice beach drive of which the inhabitants of Brownsville and

practically the whole Valley take advantage from possibly in April until October or November of each year. In driving over the beach naturally sand, shell and salt water adheres to the tires and is thrown over the running gear or chassis of a car. Returning from Boca Chica, these cars drive off the highway and through this dipping vat, the water of which reaches a level just above the running board. By so doing, virtually all the sand, shell and salt water is removed from the chassis.

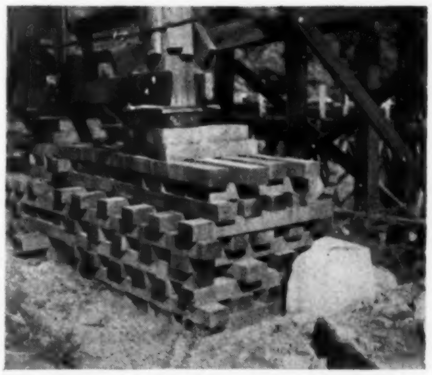
The inlet of the water to this vat is by means of a pipe and valve, and from an irrigation canal within a few feet. The vat is drained by an underground pipe and after draining, maintenance forces shovel all the sand and shell into a truck for removal. This draining and filling is done two or three times weekly during the summer months at a minimum cost to the Department, and to the great advantage of tourists and vacationists who visit Boca Chica.—*M. B. Hodges, Maintenance Engineer.*

• •

¶ Didja ever see a bridge start to move away? Rattlesnake Creek bridge on U. S. 101 in California has one end founded upon a slide. When the

maintenance superintendent found it was moving he "hog-tied" it. In pictures below you will see the bridge, one of the three turnbuckles still

holding the bridge, how a cable is hooked up, and one of the pedestals on which a column rested. The pedestal has moved away from line the amount shown. Note the cable tie



on the column in this last picture and the wedges used to prevent the cable from cutting the column.

• •

¶ No wonder California State Highway Department employees appear to talk in riddles when discussing their roads with anyone else. The state has two numbers for one road. A route might be State Route No. 15, yet at the same time it is State Sign Route No. 20. All we know about are the sign route numbers. So we get mixed up when talking to them. Punk—if you ask me. But, of course, they never asked me about it.

• •

¶ New Mexico has certainly improved their Port of Entry stations. They look habitable now.

• •

¶ I have such poor luck in New Mexico usually that I wheeled right on through the state after supper one night early in April. But I had to slow down to 60 mph in crossing those dips or I'd bash my head in.

• •

¶ Temperature: Hot as H——. See you again next month.

FLEXIBLE BASE WITH SEAL COAT

EDITORIAL

IT'S POSSIBLE—IS IT PROBABLE?

AROUND the offices of the Pennsylvania Turnpike Commission the big question of the hour is: Will the Turnpike, including the tunnels, be paved and usable to traffic by the first of July? Opinions differ. It is claimed that contractors on all of the tunnels could finish provided they secure or make up additional forms. A table herewith was prepared showing the status as of May 19, 1940, of the various divisions of the tunnel work.

The curbs and duct encasements are not included in this table as they are not absolutely necessary to provide "substantial" completion. Inserted in the table are dates of completion of the various items of construction that computations indicate could be accomplished by concentrated effort and increased pressure.

Of course, the increased pressure would cost extra money, but it is pointed out that this would be offset by less overhead costs. And it becomes a matter of conjecture whether or not the commission desires tunnel paving on July 1 to such a degree as to be willing to pay for extra costs that might be involved. Looking at possible progress without consideration of the economics involved, the figures indicate that the job can be accomplished.

Considerable transference of construction equipment from completed jobs to those in need and diligent management places the goal within the realm of possibility. High early strength or accelerated hardening cements might have to be used. Paving in the tunnels by sections, one-fourth at a time, and shifting of transportation would be necessary. Bringing additional labor from distant points, even from without the state, would have to be done, but these difficulties are not insurmountable on the premise of a disregard for the economics of the project. As the writer sees this problem, does the Pennsylvania Turnpike Commission want the completed paving done by July 1st bad enough to pay for the additional costs that might be involved.

Completion of the project by July 1st is a challenge to the contractors in management and cooperation. Accomplishment would be a tribute to the construction industry to which it could refer with pride. Any one contractor could spoil the possible record.

RECOUNTING OBJECTIVES

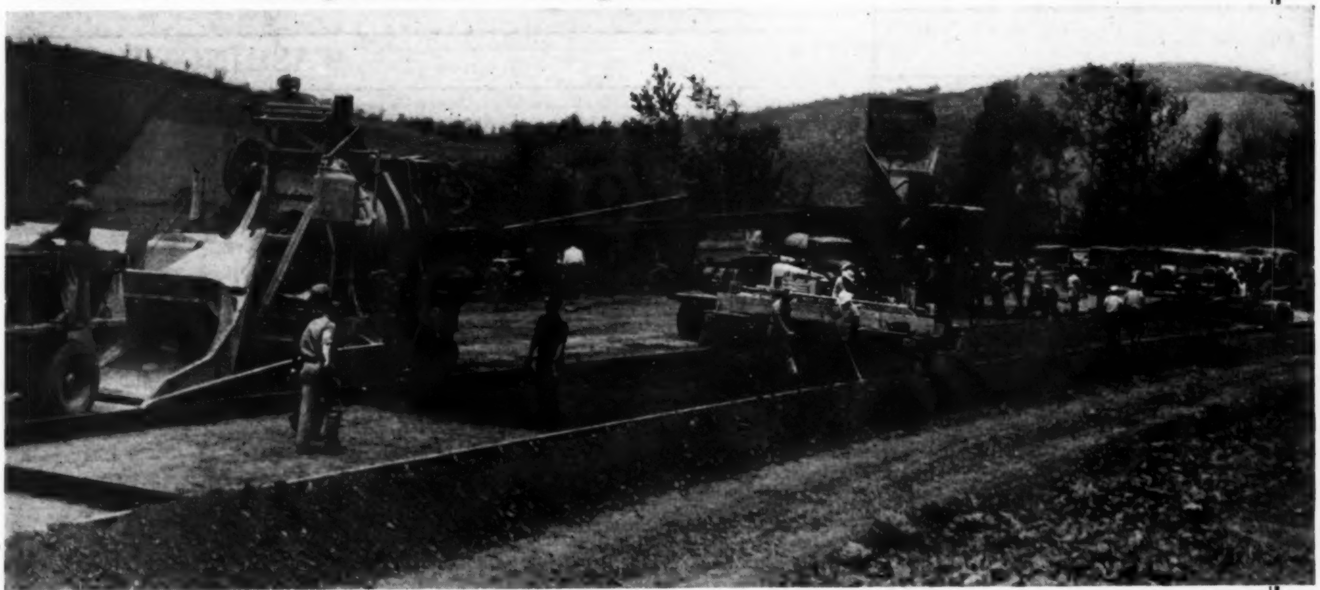
NOW that America's first long distance, express highway is about completed it would be well, perhaps, to enumerate the several judgment values underlying the design of the entire project. Mr. Chas. M. Noble, Special Highway Engineer for the Pennsylvania Turnpike Commission has stated, "Safety for vehicle operation has been the keynote in the design of the Pennsylvania Turnpike." The fundamental objectives toward which all designs of the highway facilities were pointed in providing inherent safety within the limits of funds available are as follows:

1. The separation of the streams of traffic flowing in opposite directions to reduce the possibility of head-on collisions and side-swipe accidents.
2. The elimination of all highway and railway grade crossings, so that there will be no cross traffic.
3. The elimination of the necessity for vehicles to park on the pavement and the provision of "working room" in cases of traffic emergency or mechanical failure of a vehicle by providing wide, smooth shoulders level with the pavement.
4. To reduce the menace due to slow moving vehicles, to eliminate the necessity of encroaching on the lanes of opposite direction traffic when passing, and to reduce delays in passing, two lanes of pavement in each direction, except for the tunnels, has been provided.
5. Provision of traffic lanes found to be wide enough to satisfactorily care for the safety, comfort, and convenience of the several classes of mixed traffic.
6. Elimination of all frontage, "wildcat" development, and local farm entry along the right-of-way and the complete control of the right-of-way.
7. Exclusion of pedestrian traffic.
8. Provision of moderate rates of grades in order to increase safety during icy pavement conditions and to maintain the speed of large heavily loaded trucking units so that rear-end collision between fast and slow vehicles are minimized.
9. Provision for uniform and consistent operating conditions.
10. The provision of especially designed access facilities at reasonably long intervals with acceleration and deceleration lanes in order that vehicles may enter and leave th emain highway with reasonable safety and a minimum of traffic disturbance.
11. Provision on curves and grades of slight distances long enough to permit fast moving vehicle operators to see an obstruction and to come safely to a complete stop.
12. Provision against unhealthy carbon monoxide content of the air in confined spaces.
13. Provision for adequate lighting in tunnels.
14. Landscaping and conversion of the right-of-way into a pleasing, aesthetic condition.

The desirability of these objectives has been recognized by the highway engineering profession for the past several years. This is the first time that all of them have been incorporated in a single express highway.

Tunnels	*Drainage Gallery*	*Footers*	*Side Walls*	*Length of Arch*	*Ceiling*	*Paving*	*Length of Tunnel*	*REMARKS*
Blue Mountain	6/8 2513	5/28 3785	6/8 2967	6/12 2725	6/18 1726	7/1	4172	6 more panels needed (arch, wall, ceiling)
Kittatiny Mountain	6/29 1938	5/30 3815	6/20 2664	6/23 2483	6/26 1968	7/1	4564	6 more panels needed (arch, wall, ceiling)
Tuscarora Mountain	2229	5/30 4536	6/8 3875	6/11 3635	6/17 3064	7/1	5162	
Sideling Hill	6698	6623	6/1 4470	6/18 4470	6/24 3360	7/1	6616	6 additional forms (arch, wall and ceiling)
Ray's Hill	3459	5/31 2663	6/8 2256	6/15 1805	6/25 782	7/1	3393	12 additional panels needed.
Allegheny Mountain	6072	5908	5/28 5820	5/29 5190	6/7 3420	7/1	5902	
Laurel Hill	6/1 3160	6/9 3193	6/20 2651	6/28 2169	6/30 361	7/1	4362	10 additional panels needed.

8 Ransome SINGLE DRUM DUAL DRUM PAVERS on Pennsylvania Turnpike



For Production Records, ask—Andrews & Andrews, Union Paving Company, William D. Vogel, County Construction Company, States Engineering Company, All Turnpike Contractors

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HOUSE PASSES FEDERAL-AID

Down the Road

by CHARLES M. UPHAM
Engineer-Director,
American Road Builders' Association, Washington, D. C.

PIGEONS, PREPAREDNESS AND MODERN MOTORWAYS

Nineteenth-century armies marched 20 miles a day. Twentieth-century armies roll 300 miles and more a day over modern motorways. Mechanization and motorization of armed forces drastically accelerate the mode and mobility of warfare. Wartime's tumultuous tempo pounds to the tune of hours and days instead of weeks and months. Military communications are commensurately more significant in the conduct of combat. Radio, wireless and telephone whirl the words of war with the speed of light. But telephone wires can be severed; atmospheric conditions often render radio and wireless useless. So the carrier pigeon, ancient instrument of military communications, more than holds his own in today's battle amphitheaters.

The carrier pigeon was first used as a military messenger during the siege of Paris in 1870 and 1871. Along the Western Front in the current European war more than 100,000 pigeons are on duty, twice the number used in the World War. The winged courier keeps pace with modern military developments. The United and return to a mobile loft, a militarized trailer. Although the United States has the smallest army of any major nation, it bases its defense strategy upon swift movement over America's extensive system of hard-surfaced highways. Its units are being motorized as rapidly as possible. Troops are at home in trucks. Artillery is mounted on fast-moving, gasoline-motivated wheels. And the carrier pigeon, not to be deleted from the preparedness picture, rolls right along with the army.

The signal corps of the army maintains carrier-pigeon headquarters at Monmouth, N. J., where 10.000 birds are bred and trained. Beginning training at the age of four weeks, they fly about a half mile from their base. After a year of constant coming and going, their flight range increases to more than 300 miles. The most amazing indications of their homing instinct are flights to and from army trailers which are ever changing locations.

These trailers and their pigeons, rolling with the army, contribute to American preparedness. But fluid, swift mobility would be impossible in America without good roads. Adequate preparedness means an adequate highway system. Army authorities fear that wartime traffic will be seriously impeded if released on American roads in their present state. Over 100,000 miles of our primary highway system are obsolete, constructed for the slower-moving, less-congested traffic of 15 and 20 years ago. A reassuring note is, however, struck by army officials who declare that "no military roads exist, as such, in the continental United States"; that "roads built for peacetime purposes will also serve military pursuits."

The public is becoming increasingly aware of the vital influence of both main and rural roads on the development of the nation's commerce and culture. America is growing highway conscious. Popular demand for a system of motorways designed to meet modern traffic requirements is concurrently growing with this rising consciousness. The tax-paying, highway-using public owns the highways. The public pays the motor vehicle, gasoline taxes with which highway construction and improvements are financed. As owners, the public can order that more and better roads be constructed to transport them faster, more safely and with greater comfort. The building of better roads will simultaneously increase the effectiveness of the United States Army and substantially bulwark the walls of our national preparedness. The carrier pigeon's range of communication will swell from hundreds to thousands of miles as he rapidly rolls with the army from the Gulf to the Great Lakes and from the Pacific to the Atlantic, unhindered by inadequate highways.

HOUSE PASSES FEDERAL-AID HIGHWAY BILL FOR 1942-43

The United States House of Representatives unanimously passed the 1940 federal-aid highway bill on Monday, June 3. The bill provides for the annual authorization of $178,500,000 for highway construction during the fiscal years 1942 and 1943. The money will be allotted as follows: Regular federal aid, $93,750,000; secondary federal aid, $18,750,000; grade crossings, $37,500,000; forest roads, $10,500,000; public land roads, $1,875,000; national park roads, $5,625,000; parkways, $7,500,000, and Indian roads, $3,000,000. House passage of the bill clears the way for immediate Senate consideration. In moving passage of the measure, Oklahoma Congressman and House Roads Committee Chairman Wilburn Cartwright declared, "The importance of adequate highways to all the people and the need for not only extending existing facilities but for modernizing the main routes in the interest of traffic safety and economy would justify much larger federal authorizations and appropriations than have ever been proposed. The aim of the Roads Committee has been to provide a stable and orderly program and maintain a steady, reasonable rate of progress. This bill specially authorizes the Reconstruction Finance Corporation to make loans to the states for right-of-way purchases. This provision applies only to projects eligible for federal aid and approved bv the state highway department and the Public Roads Administration." He also pointed out the importance of road construction to national defense.

ARBA STUDENT CHAPTERS AT UTAH AND PITT MEET

The ARBA student chapter at the Utah State Agricultural College at Logan, Utah, held its spring quarter dinner, April 17. Grant R. Bowen, state landscape engineer, spoke on "Beautifying Our Highways." New chapter officers were introduced by Retiring President Robert Weight. They are Blaine F. Clyde, president; Dean Fuhriman, vice-president, and Paul Leatham, secretary-treasurer. William T. Staats, assistant to the chairman, Pennsylvania Turnpike Commission, addressed a recent meeting of the student chapter at the University of Pittsburgh. He discussed "Engineering and Construction Highlights of the Pennsylvania Turnpike."

Builders' Review

JUNE, 1940

Heat-conditioned highways are just around the corner, according to a Detroit manufacturer. Heat will be turned on to dry and clear highways after rain or snow.

HIGHWAY BILL FOR 1942-43

HAL SOURS INSTALLED AS ARBA PRESIDENT

Hal G. Sours, assistant director and chief engineer, Ohio Department of Highways, Columbus, was installed as president of the American Road Builders' Assocof the annual business meeting in Washington, D. C., May 7-10. A former member of the ARBA County Highway Officials' Division and member of the board of directors, the 46-year-old president has also taken a leading part in the affairs of other professional organizations. He served as engineer for Summit County, Ohio, for eight years before joining the state highway department.

Retiring President Murray D. Van Wagoner, Michigan State Highway Commissioner, was honored at a banquet, May 9. Speakers, in addition to Commissioner Van Wagoner and Mr. Sours, were Nevada Senator Pat McCarran, Oklahoma Congressman Wilburn Cartwright, U. S. House Roads Committee chairman; Public Roads Commissioner Thomas H. MacDonald and Gar Wood, speedboat king and president, Gar Wood Industries, Inc. Members of both houses of Congress were among the distinguished guests. Robert Moses, commissioner of the department of parks, New York City, was presented with the George S. Bartlett Award for the year's outstanding contribution to highway progress. Charles M. Upham, ARBA engineer-director, presided at the banquet.

State and county highway officials, highway engineers and designers, manufacturers, safety experts, contractors, public relations men and educators met in special conferences during the four-day conclave. The necessity for ousting "labor gangsters" from the highway industry was the subject of talks by Commissioner Van Wagoner and Joseph J. Cavanagh, general manager, Chicago Motor Club, before the Highway Contractors' Division. W. A. Young, president, Georgia Highway Contractors' Association, was elected to succeed the late W. R. Smith as vice-president of this division. A delegation from the County Highway Officials' Division conferred with H. S. Fairbank, chief, Public Roads Administration division of information, on the future of the secondary road program. The division planned increased activity in interesting local highway agencies throughout the country in ARBA membership. A May 9 dinner-meeting of the ARBA District of Columbia Section, which was host to out-of-town delegates, was addressed by Captain H. C. Whitehurst, section president and D. C. director of highways, and John Jay Daly, "Washington Star" feature writer and radio commentator.

County Officials Talk Over May Meeting Decisions and Activities. Photographed after the County Highway Officials' Division Breakfast Are, Left to Right, Allan Williams, Ionia County, (Mich.), Road Commission Engineer; J. C. Akers, Nashville, Tenn.; Carl T. Bowen, Ottawa County, (Mich.), Road Commission Engineer; Otto S. Hess, Kent County, Michigan, Engineer and Director of the ARBA, and Leon Belknap, Oakland County, (Mich.), Road Commission Engineer and Newly Elected President of the ARBA County Division.

PAUL ANDREWS IS WINNER IN ARBA GOLF TOURNAMENT

Paul L. Andrews, executive secretary, Georgia Highway Contractors' Association, led the field of sixty players to turn in low-net score in the annual ARBA golf tournament. His name was inscribed on the permanent ARBA trophy and he received a replica of the cup, suitably inscribed, for his own possession. Among other road builders who took prizes for their skill at Washington's Congrossional Country Club, May 8, were Homer G. Farmer, technical service director, Universal Atlas Cement Co., New York City, low gross; Maurice R. Palmer, sales manager, A. P. Woodson Co., Washington, D. C., second low gross; Hal G. Sours, new ARBA president, Columbus, Ohio, second low net; George H. Kimber, sales manager, Solvay Sales Corp., New York City, third low gross; C. W. Lucas, director of public relations, Michigan State Highway Department, Lansing, third low net, and J. Reginald Boyd, secretary, National Crushed Stone Association, average golfer.

Forty-one prizes were donated for the tournament. Donors, in addition to the American Road Builders' Association, include American Chain and Cable Co., Inc., Bridgeport, Conn.; Bendix-Westinghouse Automotive Airbrake Co., Pittsburgh, Pa.; Calcium Chloride Association, Detroit, Mich.; Caterpillar Tractor Co., Peoria, Ill.; Rufus H. Darby Printing Co., Washington, D. C.; Dimick-Mosher Products Co., Boston, Mass.; Firestone Tire & Rubber Co., Akron, Ohio; Gatke Corp., Chicago, Ill.; Gulf Oil Corp., Pittsburgh, Pa.; Hercules Motor Corp., Canton, Ohio.; Jaeger Machine Co., Columbus, Ohio; Koppers Co., Pittsburgh, Pa.; Loew's Theaters, Washington, D. C.; Macwhyte Co., Kenosha, Wis.; "Roads and Streets," Chicago, Ill.; Schramm, Inc., West Chester, Pa.; Simplicity System Co., Chattanooga, Tenn.; Sport Center, Washington, D. C.; Asphalt Institute, New York City; Thew Shovel Co., Lorain, Ohio; Warner Bros. Theaters, Washington, D. C., and A. P. Woodson Co., Washington, D. C.

C. W. LUCAS HEADS ARBA PUBLIC RELATIONS GROUP

C. W. Lucas director of public relations, Michigan State Highway Department, Lansing, was installed as president of the newly organized ARBA Public Relations Division at its first annual meeting in Washington, D. C., May 8. Plans were made to co-ordinate the various public educational activities of the highway-transportation profession and industry.

(*Continued from page 84*)

Tightening on the Inside from a Simple Movable Platform

of the structure. The second and third rows of plates were then placed at the upstream end, continuing with a plate on one side and then one on the other to maintain balance until the first top plate was in place. The next row of plates then started at each side of the base plate, being carried up in the same alternate manner; and this procedure was continued until all the plates were in position.

To facilitate placing and tightening the bolts, a rigid timber platform was built, using four 2 x 6 legs with 2 x 6 bracing and using 2 x 12 loose planks for the deck. Under each leg there was placed a 2 x 6 shoe which rested just above the seam between the second and third bottom plates on each side of the pipe. This platform was comparatively light and easy to move, six men being required when platform was empty and eight men easily moved it when it was heavy with bolts and nuts. The platform was the full width of the pipe and 14 ft. long.

About a fourth of the bolts were loosely placed in each seam as the plates were erected with no omissions where three plates lapped.

An average crew of 10 men, all common laborers, were used in the erection. They worked in pairs, one inside and the other outside. When all the plates were in place, the crew worked back through the pipe, putting in the rest of the bolts and tightening all of them. The men on the outside used a scafforld of a single plank between two iron slings hooked into bolt holes.

Strutting

In order to offset the normal deflection of the pipe under load, the pipe was strutted. Strutting was started at the upstream end and carried on in the usual manner. Two 75-ton jacks were borrowed from the Northern Pacific Railway Company. These were quite heavy to move, but no trouble was encountered in getting full 6 in. deflection with them; and it is doubtful if this could have been accomplished with lighter jacks for the No. 1 gage plates. Timber for strutting the 180-in. diameter Multi Plate consisted of two 8 x 8 top sills, 8 x 10 compression caps, 10 x 10 posts on 4-foot centers, and one 8 x 10 bottom sill. All the sills were in 16-ft. lengths so that no top and bottom sill joints were at the same post. The movable platform was very useful in the strutting operation.

After strutting, it was naturally found that a great number of bolts were loose. The movable platform was then cut in two pieces and each part moved back through the pipe, one on each side of the posts. Every bolt and nut was again tightened; and the nuts on the outside were tightened first because in this type of 6-bolt construction four of the nuts are on the outside of the pipe and two inside, and tightening the four nuts on the outside will pull the plates together more than is possible with the two inside nuts.

Labor Organization and Costs

A total of 1,647 man-hours of common labor at 65 ct. per hour was used in the handling, erection and strutting of this 180-in. diameter multi plate pipe. This included building the rigs mentioned, but not the lumber used for scaffolds and strutting; nor did it include the cost of the wrenches and hardware. This labor cost of $1,070.55 shows a cost per foot of pipe per plate on this 180-in. diameter of $0.446. This cost may seem high but it must be remembered that by far the greatest part of time in erection was actually spent in putting in bolts and nuts, and this pipe had six bolts per foot instead of the usual standard four bolts.

The wrenches used were made especially for the job by a local foundry. These were open end wrenches with 18-in. tapered handles so that the handles could be used as reaming bars. For final tightening, regular socket wrenches were used.

Constructing the 10-Ft. Pipe

There was a lapse of about two weeks between the erection of the 180-in. and the 120-in. diameter Multi Plate pipe. However, several men used in the first crew were still available so it was not necessary to break in an entirely new crew. The procedure was much the same as for the larger pipe. The same outside rig or derrick was used, the only difference being that the boom was cut to a length consistent with the diameter of the pipe.

Labor costs were somewhat less than for the larger pipe. For the strutting operations, smaller timbers were used.

Backfilling both pipes was completed in the spring of 1940. The timber struts will be removed when it is decided the fills have attained full compaction and settlement.

Personnel

Construction was under the supervision of the Montana State Highway Commission, Col. D. A. McKinnon, chief negineer; H. C. Tilzey, division engineer of Division No. 5, Missoula; B. J. Ornburn, bridge design engineer; P. G. Poore, pre-construction engineer; and S. C. Bonesteele, resident engineer. The contractor on the grading and culvert jobs was Sam Orino of Portland, Oregon; H. Larson and Al Mattson, superintendents; and J. R. Kaiserman of the Montana Culvert & Pipe Co., who supervised the pipe construction.

MONTANA NATIONAL BITUMINOUS CONFERENCE POSTPONED TO 1941

The Sixth Annual Montana Bituminous Conference is postponed to the fall of 1941—location and exact date to be determined and announced later.

NEW EQUIPMENT AND MATERIALS

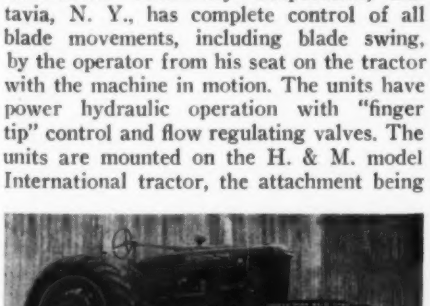
New Bituminous Maintenance Plant

A complete, small bituminous plant, capable of feeding itself, drying the aggregate, heating the bitumen, accurately proportioning the aggregate and bitumen, and delivering a homogeneous mass either to trucks or wheelbarrows, has been announced by Barber-Greene Co., Aurora, Ill. It consists of two basic units, a mixer and a dryer, each of which can be towed at truck speed. No auxiliary equipment is necessary. With the material available, the owner only needs to have trucks or wheelbarrows for hauling the mix away. The new plant can be set up in a number of combinations. The mixer can operate either with or without the dryer. The pugmill can discharge directly into wheelbarrows or be set up with an accessory conveyor for elevating the material into trucks. The dryer can be fed either by small drag line which operates from the mixer power unit or any other means. This plant is built for the "three or four block" paving job, short resurfacing jobs, patching, general maintenance work, tennis courts, driveways, alleys, etc. The plant is not only completely self-operating but is complete in its ability to deliver any type of mix desired, incluidng the higher type mixes. The pugmill is steam-jacketed. Working on the same principle as the larger Barber-Greene continuous mixers, this plant is stated to have a capacity from 200 to 300 tons of finished mix per day.

New Barber-Greene Maintenance Plant

New Patrol

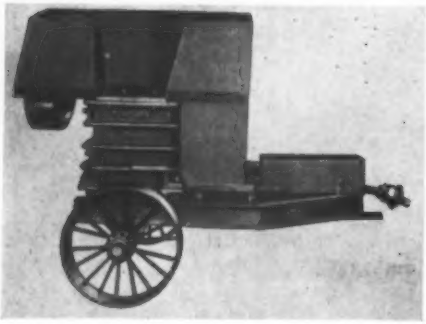
A new tractor patrol brought out by Contractors Machinery Corporation, Batavia, N. Y., has complete control of all blade movements, including blade swing, by the operator from his seat on the tractor with the machine in motion. The units have power hydraulic operation with "finger tip" control and flow regulating valves. The units are mounted on the H. & M. model International tractor, the attachment being made without drilling any holes in the tractor or making any change in the tractor fittings. The entire unit may be fitted to the tractor in a few hour's time and is readily removable leaving the tractor free for work of a different nature. In order that the tractor may be used for other purposes than road maintenance and work of a similar nature, the rear power take off connection and the draw bar connection is not interfered with in any manner. The rear power take off may be used with a mower or other tool requiring the use of the rear power take off, and the draw bar is always free, permitting the tractor to be used as a power unit for other drawn equipment.



New Trojan Utility Patrol

New Portable Crusher

A crusher designed for fast portability to break down rock or gravel excavated during grading so that the crushed material can be rolled right back into road bed instead of roadside stacking or trucking away has been added to the line of the Diamond Iron Works, Inc., Minneapolis, Minn. The crusher will travel into any roadside pit where the tractor can go. The crusher is powered from the rear power

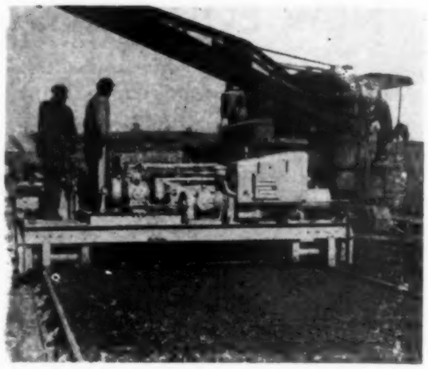


New Portable Crusher

take-off of any tractor through a flexible joint drive shaft and V-belts, and will operate for crushing scattered stones while the tractor is traveling. These units are made in several crusher sizes to meet operating conditions, and all moving parts are enclosed for safety to workmen.

New Paving Spreaders

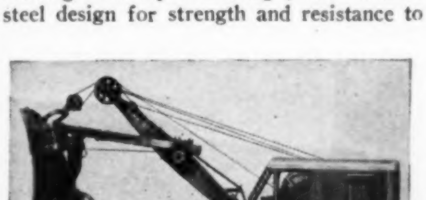
A paving spreader developed by Blaw-Knox Co., Pittsburgh, Pa., has a spreading blade that moves the concrete forward as well as spreading it laterally. This spreading operation is automatic and it is stated that all parts of the roadbed are filled to proper thickness and grade without regard to operator alertness or control, and without the necessity of intermediate handling. Among the advantages claimed from this method of spreading is a reduction in the power and tractive effort required for the spreader machine. Because the spreading blade clears a path ahead of the machine, there is less necessity for the machine to bulldoze its way into the concrete—that is, to "buck off" the load. A further advantage claimed is that the spreader not only provides a normal adjustability for width but can be built to handle any width of pavement—while keeping the power requirements and weight of the machine within reasonable limits. Both the spreading blade and strike-off plate are quickly adjustable for levels below the forms to accommodate laying the steel mesh in two course work. The spreader can also be furnished with a vibrator attachment for vibrating both courses; when so equipped, the strike-off plate and vibrator are a complete unit. It is stated the machine leaves the concrete properly spread and conditioned for finishing, eliminating manual spreading between paver and finisher. The machine is driven through an automatic type unit transmission. It is provided with three speeds for both reverse and forward travel, the three speeds being 11, 20 and 122 ft. per minute on machines up to 14 ft. wide; and 8, 14 and 90 ft. per minute on wider machines. Convenient transportation wheel assemblies are provided wherever required.



The Blaw-Knox Spreader

New 1 to 1¼ Yd. Shovel

A new 1 to 1¼ yd. convertible shovel-dragline-crane, Model LS-100, has been announced by Link-Belt Speeder Corp., 301 West Pershing Rd., Chicago, Ill. The machine is controlled by easy-throw levers and equipped with a new type of clutch. Further features are: fully enclosed travel brakes controlled from cab; fully enclosed traction gears running in oil; a 72-in. diameter machine-finished roller-path turn table with patented, self-aligning rollers; anti-friction bearings throughout; free floating center-pin bearings; and welded steel design for strength and resistance to

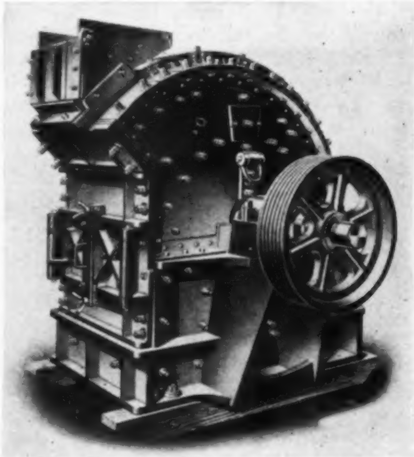


New Link-Belt L-S 100 Shovel

shock loads and to provide positive alignment of machinery parts. The engine is a heavy-duty industrial type gasoline or diesel. Track shoes are 24 in. standard (30 in. optional); crawlers are smooth, self-cleaning and perfect guiding. The machine may be quickly converted from one excavating or handling attachment to another, without mechanical alteration.

New Rock Breaker

A new product of the Iowa Manufacturing Co., Cedar Rapids, Ia., is a slow-speed, fixed bar breaker which is stated to produce a uniform cubical product in any size required by simple variation of speed. In this "Kubit" breaker, the stone or other material is broken solely by impact. Breaker bars, rigidly fixed to a balanced rotor throw the material with shattering force against V-shaped impact bars, splitting the material along its natural grain.

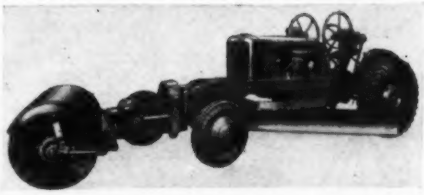


Cedarapids "Kubit" Impact Breaker

The broken pieces rebound from the bars to be again thrown against successive bars as the product travels downward. The broken material leaves the machine through a large opening in the bottom of the breaker. This discharge opening is unrestricted by grid bars or screen. There are no grates to wear out. The size of the broken material varies according to the speed of the rotor. Higher speed produces smaller material. It is stated that since there is no grinding action employed, maintenance is kept at a minimum and the finished product is uniformly cube shaped. Anyone interested in having samples of materials "Kubitized" in the "Kubit" Breaker may do so by sending them direct to the Iowa Manufacturing Co., Cedar Rapids, Ia. Your material will be processed and returned for your inspection.

Sweeper on Patrol Grader

The Allis-Chalmers patrol grader powered by a Model "W" tractor is now available with a front end power broom, made by Frank G. Hough Co., Libertyville, Ill. The addition of this 6-ft. broom unit greatly increased the availability of this unit and allows for doing many additional road maintenance jobs. Blade can be sloped or angled right or left and is rigidly supported on a turntable hung below the tractor chassis. Broom has controlled



Power Broom on Patrol Grader

ground pressure, sweeps one way and can be used simultaneously with blade where occasion requires. The manufacturer claims durable construction, high efficiency, extended service life for brooms because of simple reversibility, positive power application through cut gear transmission and all operating actions easily controlled from operator's platform.

New Full Revolving Crane

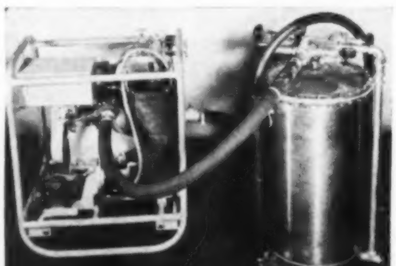
A new full revolving crane, convertible to shovel, dragline, clamshell or backdigger, mounted on a specially designed 10-wheel, rubber-tired carrier, has been brought out by the Thew Shovel Co., Lorain, O. Among the features built into this "crane carrier" are: 3-axle mounting supported on 10 rubber tires. Both tandem rear axles drive. Mounting is built of standard parts available all over the country. 175-in. wheelbase for better maneuvering. Special steering gear built for soft ground travel. Special chassis frame design which eliminates reinforcing. 10 speeds forward (high, 28 to 31 m.p.h.)—and 2 reverse. The turntable is built to balanced center drive design, employing the patented sloping machinery frame. Power is

Thew "Moto-Crane"

delivered from the motor to the center drive pinion, by means of a roller chain power take-off. The center drive pinion, in turn, powers directly the hoist and swing shafts. Thus full engine power may be concentrated on either operation, or may be spread, in the proper balance, between related and synchronized simultaneous operations. Moto-Cranes are built in 5 models, ranging from units in which minimum total weight is the main objective up to big-capacity, heavy-duty units that will carry 100-ft. or longer booms In all models the same general design principles, construction and features are used.

Water Purification Unit for Construction Camps

A complete portable water purification and pumping unit that makes it possible to have clear, safe water on the job, using a supply from stream, pond, lake or well,



Pur-O-Pumper Unit

is being made by Proportioneers, Inc., 9 Codding St., Providence, R. I. The unit, developed for army use, makes it possible in many instances for a contractor to locate his construction camp in localities that otherwise would not be considered because of the lack of a suitable water supply. The standard unit has facilities for filtration, for alum and soda ash feeding, for hypo-chlorination and pumping. One standard unit weighing 700 lb. has been tested with pumping capacities and filtering rates of nearly 20 GPM, which through by passing the filters may operate as a sraight pumping and chlorination plant up to 40 GPM.

New 2-Ton Truck

A new 2-ton cab-over-engine model has been added to the extensive line of job-rated trucks of the Dodge division, Chrysler Corporation. The new 2-ton is a companion to the Dodge job-rated 1½-ton cab-over-engine truck. It is modernly streamlined for striking appearance. Its L-head Dodge truck engine with 241.5 cu. in. piston displacement and a 6.5 to 1 compression ratio develops 99 hp. at 3,000 r.p.m. and a maximum of 188 foot pounds torque at 1200 r.p.m. It has all the advanced and proved features of Dodge design. Included are exhaust valve seat inserts, full length water jackets and water distributing tube, five-speed transmissions, hypoid rear axle and booster-actuated equal pressure hydraulic brakes. Offered in three wheelbase lengths, 105, 129 and 159 in., the new 2-ton cab-over-engine truck has a maximum gross weight rating of 15,000 lb. in conventional use and 25,000 lb. when operated as a tractor-trailer unit.

New Drag Broom

A new drag broom having its wire bristles set in all metal blocks has been brought out by the W. E. Grace Manufacturing Co., 6000 Holmes St., Dallas, Tex. A special spring wire is used in these brooms, and the metal blocks may be refilled if the original wire filling

New All Metal Drag Broom

wears out. The broom is suitable for light aggregate as used in seal coat work and can be weighted with several hundred pounds ballast for handling base courses of large aggregates. The complete broom consists of two 8-ft. sections and two 10-ft. sections, with adjustable clips for setting the sections at various angles on the hitch bars provided. The weight is about 250 lb.

New Full Capacity Beam for Truck Scale

A new full capacity beam for motor truck scales, announced by Fairbanks, Morse & Co., 600 South Michigan Ave., has all graduated face plates set at an angle of 45 degrees which permits a tall or short person to read from a natural standing position. These plates are made of aluminum and have large, black, etched in figures. These are veary easy to read, and reduce eye strain to a minimum. All poises are center indicating, of the open face type which do not cover nor obstruct graduated face plates. Main poise and main tare poise have stainless steel roller bearings which run on a machined track to provide easy and fast operation. The main poise and main tare poise are both equipped with positive seating stainless

steel poise dogs located in the center of the poises and operating in a vertical plane from convenient finger-form side handles. The poise dogs engage in 90 degree notches which are accurately machined on the underside of the beams. The new beam is available with or without tare-bar. All working parts are scientifically heat treated to insure precision fit and continued accuracy. The entire beam, except the aluminum face plates, is finished in slate gray, durable crackel enamel.

New Spreader

A new gravity spreader has been brought out by the Burch Corporation, Crestline, O. The spreader is suspended under the tailgate and adjusted to the truck by means of a ratchet type winch and cable as shown in the illustration. It can be attached to truck in two minutes. The spreader is a gravity feed and it is stated it will lay an accurate stone mat from 12 in. to 9 ft. wide using material up to 1 in. in

New Burch Gravity Spreader

diameter. The amount of material to be laid is governed by a movable gate operated with a lever. It will operate with the truck moving backward as well as forward.

New Tire for Leaning Wheel Graders

A new tire designed for leaning wheel graders is the latest development of the tire division of the B. F. Goodrich Co., Akron, O. The tires are available in three sizes. 6.50-20, 7.50-24 and 8.25-24. Because

New Tire for Leaning Wheel Road Graders. The Picture Illustrates One of the Angles at Which the Tire Can Operate

the tire has no definite shoulder it is stated it will ride naturally at any angle without undue wear or strain. The usual tread surface is protected with a heavy, deep, grooved tread to resist side-slip for operations in ditches or on road shoulders. The "ankles" or the side-walls of the tire have radial cleats to prevent slipping and to keep them rotating even when the wheels are working at an angle in muddy going.

New Hydraulic Hoist

A new single cylinder telescopic hydraulic hoist claimed to handle unusually heavy loads with ease has been introduced by the Heil Co., 3000 W. Montana St., Milwaukee, Wis. The hoist proper consists of a main cylinder having a 9 in. bore, supported in an all-steel box girder cross support. This support pivots in broad saddles attached to the chassis frame. The base is fitted with a flange so that the valve housing can be bolted on to the base casting. The hoist has been designed in either two, three or four telescopic sleeves depending upon mounting conditions. The hoist crosshead shaft provides flexible attachment to the body subframe. This new unit is designed especially for mounting on 6-wheel, 4-wheel drive trucks or on standard 4-wheel drive trucks with side propeller shaft. However, its use is not restricted to such models. It has a low mounting which varies between 8 and 15 in. depending on tire clearances as well as hoist clearance of the truck mechanism. All unnecessary interference with the truck running gear is eliminated by the exceptionally compact design of the hoist mechanism. To prevent the body from dropping suddenly in the event the pressure fails, the hoist is fitted with a check valve on the high pressure side. The complete assembly, including all necessary connecting parts, power take-off, etc. is only 950 lb. The separate Heil precision-built pump can be located anywhere forward of the hoist. The pump is equipped with roller bearings and replaceable wear plates. The holding valve assembly is designed to raise, lower or hold the body at any desired angle.

New Mower

A new mower has been brought out by the Little Giant Products Co., Inc., Peoria, Ill. The mower has twin sickles and all

operations of the sickle bar assembly are independent of one another. The mower is hydraulically controlled, vertical, horizontal. and below horizontal 45 degrees. The driving head is controlled vertically within a 12-in range. The sickle bar may be titlted

upward or downward. All the control is through the hydraulic valve controls placed conveniently before the operator. The mower is furnished for all cultivator-type tractors.

New Streamlined Cab

The Orrville Body Co., Orrville, O., has designed a new streamlined, steel, all-weather cab for the Galion motor patrol. This company has been furnishing custom-built cabs for various types of construction

New Streamlined Cab for Galion Motor Patrol

equipment, including power shovels, for the past 15 years. Mr. A. C. Vetter, formerly chief cab engineer of White Co., is now associated with this company in the capacity as chief engineer.

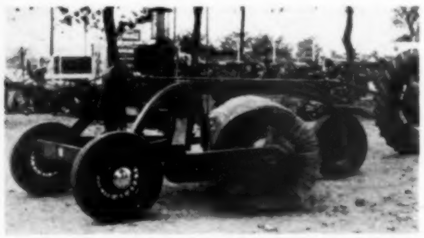
New Crawler Crane

A new 60-ton heavy-duty crawler crane has been added to the line of the Lima Locomotive Works, Inc., Lima, O. This new crane makes their current line of cranes range in capacities from 13 to 60 tons. Features incorporated in Lima cranes include: Independent clutches—hoist, travel, swing and boom up or down simultaneously. Four Drums—including worm-driven boom hoist. Smooth operating clutches, controlled by vacuum. Helical cut gears throughout the main machinery. Roller bearings at every vital bearing point. Square lever shafts—no keys to work loose—positive lever action. Arrangement of main machinery affords proper balance for handling long booms at low angles. Special steels are used throughout, to effect longer and profitable operation, with fewer delays. Big diameter drums with wide face effect greater cabie economy.

New Lima 60-Ton Crawler Crane

Grace Sweeper Now Available for Use with Tractor

The two-way traction driven sweeper of the W. E. Grace Manufacturing Co., 6000 Holmes St., Dallas, Tex., used by asphalt contractors, is now available for use with a tractor, the brush being driven by the tractor power take-off. This provides for



Grace Sweeper

a sweeper with independently power brush instead of the traction drive. A wide number of combinations of brush speed and ground speed are available, as the power take-off drives through the regular 3speed transmission with Ford gears furnished on the traction driven sweeper. It is stated the machine may be converted back to the regular traction driven model in about 15 minutes, it being only necessary to remove one chain.

WITH THE MANUFACTURERS

Maine Truck & Tractor Co. New Distributor for Hercules Co.

The Hercules Co., Marion, O., manufacturers of Hercules rollers and *Ironerrolls*, announces the appointment of the Maine Truck and Tractor Co., 158-162 Veranda St., Portland, Me., as their distributor for the whole state of Maine.

Demonstration of Mixed-in-Place Construction with Rototiller

The third annual field day of Rototiller. Inc., 102nd St. and 9th Ave., Troy, N. Y., will be held July 6. A feature of the day will be a demonstration of the making of a small section of oil in-place-mix roads and cement in-place-mix roads, using rototillers for the entire construction work from the first breaking of the ground to the final completion of rolling.

Donald D. Kennedy Announces Formation of Kennedy-Cochran Equipment Co.

Donald D. Kennedy, who has been sales engineer for the Foote Co., Inc., in the Midwest during the past four years, announces his resignation from that firm in order to form the Kennedy-Cochran Equipment Co. with offices at 228 N. La Salle St., Chicago, Ill. This new company succeeds the Paul Cochran Equipment Co. which has been dissolved. The new firm will handle the distribution of Buckeye ditchers, shovels, tractor equipment, spreaders and R.B. finegraders; and Worthington compressors. Mr. Kennedy has had a broad selling experience in road building and construction fields and is familiar with operations and methods throughout the entire midwest where he is well known to contractors and highway officials alike.

Truscon Promotions

W. V. Peters and C. B. McGehee have been appointed managers of sales, Truscon Steel Co., Youngstown, O., in charge of northern and southern areas, respectively. Mr. Peters formerly was assistant general manager of sales, and before that was successively district sales manager in Cleveland and manager of sales, steel window division in Yonugstown. Mr. McGehee, until his appointment as manager of sales, southern area, was manager of sales, highway products division in Youngstown and district sales manager in Atlanta, Ga., and Dallas, Tex. These appointments followed the resignation on May 10th of Grover J. Meyer, formerly general manager of sales.

W. V. Peters

C. B. McGehee

New Distributors for Osgood

The Osgood Co., Marion, O., manufacturers of excavating and material handling machinery, has announced the appointment of the following distributors: The Machinery Rental and Sales Co., 2837 Southwest Blvd., Kansas City, Mo., for the territory consisting of the counties of Western Missouri and Eastern Kansas. The C. Taylor Handman Co., 800 Temple Bar Bldg., Cincinnati, O., to serve the Cincinnati area, with counties in Southwestern Ohio, Southeastern Indiana, and Northern Kentucky. The K. B. Noble Co., 761 Maple Ave., Hartford, Conn., to serve the entire state of Connecticut, and four western counties of Massachusetts.

Intermountain Equipment Co. Appointed Distributor for Hercules Co.

"The Intermountain Equipment Co., Broadway & Myrtle Sts., Boise, Idaho have been appointed distributors of the Hercules road rollers, manufactured by the Hercules Co., Marion, O. The territory which they will serve consists of the southern part of Idaho, and Malheur County, Oregon."

Handman Co. Appointed Distributors for General Excavator Co.

The General Excavator Co., Marion, O., has appointed the C. Taylor Handman Co., 800 Temple Bar Bldg., Cincinnati, O., as distributors for General excavating and material handling equipment.

W. H. Insley Retires

W. H. Insley, who founded the Insley Manufacturing Corporation, Indianapolis, Ind., some 35 years ago, has sold his controlling interest of stock in that concern and has retired. The interest was purchased by the Joseph Reid Gas Engine Corporation of Oil City, Pa., which will continue to operate the Insley plant under its present name with no change in product or sales policy. The officers of the new company are Dallas E. Winslow, President and Treasurer; W. R. Dunlap, Vice-President and Secretary; F. B. McKaig, Vice-President and Assistant Treasurer; C. H. Lippincott, Vice-President and Assistant Secretary. Ray Dorward will continue in his present capacity as sales manager. The new management operates various other plants throughout the Eastern and Middle Western States and its wide experience in diversified industrial manufacturing, and ample working capital, will greatly strengthen the present organization. The Insley Co. at the present time is enjoying an exceptionally good spring business and, due to the new management, is looking forward to an even greater 1940.

Telford Equipment Co. Appointed Distributors for General Excavator Co.

The Telford Equipment Co., 735 Kalamazoo Street, Lansing, Mich., will distribute the complete line of General excavating and material handling equipment for the General Excavator Co., Marion, O. Territory consists of counties in Northern, Central, and Southern Michigan.

R. S. Brown Joins Foote Co.

The Foote Company, Inc., Nunda, N. Y., manufacturers of Adnun black top pavers and Multifoote concrete pavers, has announced the appointment of R. S. Brown as sales engineer for the midwest territory with headquarters at 2139 W. Fulton St., Chicago. Mr. Brown, a graduate civil engineer of Purdue University, has had a broad experience in the construction field and was most recently associated with the Concrete Steel Co., Chicago. He will replace Donald D. Kennedy who recently left the Foote Co. to effect formation of the Kennedy-Cochran Equipment Co.

A Correction

In the 1940 edition of Powers' Road and Street Catalog the wrong page number was given in the listing of the National Traffic Guard Co. in the Classified Buyers Section. The advertisement of that company appeared on page 115 and consequently the listing in the Buyers Section should have been 115 instead of 118.

Talco Asphalt & Refining Co., Incorporated

Talco Asphalt and Refining Co., a co-partnership heretofore composed of D. H. Byrd, Jack Frost, J. F. Lucey and Ralph E. Fair, has been dissolved, and the business heretofore conducted by the co-partnership has been acquired by Talco Asphalt & Refining Co., Mt. Pleasant, Tex., a corporation incorporated under the laws of the State of Texas, which will henceforth conduct the business under the same name.

Brumleve Co. Appointed Distributor for Ransome

Ben. J. Brumleve Co., 809 S. 8th St., Louisville, Ky., has been appointed distributor in central Kentucky for the complete line of equipment as manufactured by the Ransome Concrete Machinery Co., Dunellen, N. J.

Charles N. Fitts Elected Honorary Member American Institute of Steel Construction

Charles N. Fitts of Boston, Mass., has been elected an honorary member of the American Institute of Steel Construction. Mr. Fitts was, until his retirement from the industry last year, a director of the Institute from the time it was organized, and a member of the executive committee for the past ten years. He was president of the American Institute of Steel Construction from 1928 to 1932 and directed its affairs during a most trying time. Mr. Fitts is a Virginian by birth and attended Massachusetts Institute of Technology. He joined the New England Structural Co. in 1895 and was Treasurer of that organization until it was decided to liquidate in 1939.